AIRCRAFT BLOCK SPEED
CALCULATIONS FOR
JOSAC/USTRANSCOM AIRCRAFT USING
LINEAR REGRESSION

GRADUATE RESEARCH PAPER

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Abstract

Joint Operational Support Airlift Center (JOSAC)/United States Transportation Command (USTRANSCOM) long range flight planners utilize a number of formulas and planning factors when planning missions. Air Force Pamphlet (AFPAM) 10-1403, Air Mobility Planning Factors, includes an aircraft block speeds table for USAF Major Weapons Systems (MWS) and Civil Reserve Air Fleet (CRAF) aircraft. This table provides flight planners a reference to quickly determine aircraft flight times between airfields based upon distance. They can subsequently use this information to plan the mission crew duty time (CDT) and flight duty periods (FDP) for each mission they plan. Currently, no aircraft block speeds table exists for Operational Support Airlift (OSA) aircraft. This research provides a method to calculate the aircraft block speeds table for JOSAC/USTRANSCOM aircraft.

Evaluation of the model used in building the aircraft block speeds table requires examination of almost 200,000 flights over the course of almost five years. A linear regression model is incorporated resulting in unique equations that are used to create aircraft block speeds for specific flight distances. For the given data set, each flights distance versus average flight time is regressed, providing an equation for the average predicted distance per unit of flight time. Additionally, each flights average speed versus distance is regressed, providing an equation for the predicted speed per unit of distance.

23 different United States Air Force (USAF) OSA aircraft models are examined. These aircraft are further broken down into 13 different groups based upon aircraft cruise speed. Regression statistics are analyzed and used to determine the significance and

goodness-of-fit of the model to each aircraft. Results obtained from this research provide insights into the usefulness of a JOSAC/USTRANSCOM aircraft block speeds table. Overall, the models do a good job of predicting the speed of each aircraft per unit of distance. Based upon this research, it makes sense to create an OSA aircraft block speeds table to be used by JOSAC/USTRANCOM for long term mission planning.

To my wonderful wife and kids.

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Adam D. Simoncic

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AIRCRAFT BLOCK SPEED CALCULATIONS FOR JOSAC/USTRANSCOM AIRCRAFT USING LINEAR REGRESSION

I. Introduction

Background

The Joint Operational Support Airlift Center (JOSAC) is the single manager for scheduling all Department of Defense (DoD) continental United States Operational Support Airlift (OSA) requirements. As part of United States Transportation Command (USTRANSCOM), JOSAC performs consolidated scheduling of continental United States OSA aircraft. OSA missions move high priority passengers and cargo while improving readiness and providing cost-effective training of aircrews (Department of Defense United States Transportation Command, 2010). In order to accomplish its mission, JOSAC utilizes long range mission planners to build flying missions. They need to be able to quickly check the big-picture feasibility of proposed OSA missions. Specifically, they need to see if an aircraft and crew can fly a certain mission within a certain time frame. Whether or not they can drives how the planners build that specific mission in terms of type and number of aircraft, number of crews, and days allotted to each mission.

JOSAC long range mission planners have several tools to use at their disposal. They use airlift and aeromedical evacuation formulas and mobility planning factors taken from Air Force Pamphlet (AFPAM) 10-1403, Air Mobility Planning Factors. However, one tool they do not have is an aircraft block speed table designed specifically for OSA aircraft. Aircraft block speed is an average speed per aircraft per distance that can be used to estimate mission flight duty period (FDP) and crew duty time (CDT). An aircraft block speeds table exits in AFPAM 10-1403 for USAF Major Weapons Systems (MWS) and Civil Reserve Air Fleet (CRAF) aircraft, but not for OSA aircraft.

This paper is specifically concerned with whether or not it makes sense to build an aircraft block speeds table for OSA aircraft. It examines almost 200,000 OSA flights over the course of almost five years, taken from a USTRANSCOM database. It breaks 23 different aircraft up into 13 groups based upon aircraft cruise speed. A linear regression model is used to determine unique equations that can then predict each groups speed per unit of distance, and ultimately, each groups block speed per unit of distance. Finally, regression statistics are analyzed and used to determine the significance and goodness-of-fit of the linear regression model to each aircraft group.

Problem Statement

The purpose of this research is to determine, based upon an analysis of historical data, whether or not it makes sense to build an aircraft block speeds table for OSA aircraft, and if it does, to create that flight planning tool.

Research Objectives

To understand if an aircraft block speeds table for OSA aircraft makes sense to build, this research effort has set forth the following research objectives:

- Determine the linear regression equation predicting speed versus distance for each aircraft.
- Through an examination of each aircraft's regression statistics, determine how well the data observations are replicated by the linear regression model.
- If the linear regression model is deemed appropriate, build an aircraft block speeds table for OSA aircraft.

II. Literature Review

Overview

This chapter provides a discussion on the use of air mobility planning factors and aircraft block speed tables. It examines how block speeds are calculated and why they are important to the global air mobility system. Finally, this chapter provides an overview of the linear regression model definitions, statistics, and techniques.

Air Mobility Planning Factors

Air mobility planning factors are designed to help flight planners make gross estimates about mobility requirements in the early stages of the flight planning process. They provide flight planners approximations that can be used to determine the suitability of a specific mission given certain parameters. They are planning factors to be used well prior to mission execution, and as such, should not be used for short term mission planning (HQ AMC/A3XP, 2011).

Calculations for the Number of Cargo Missions Required, Number of Passenger (PAX) Missions Required, Total Missions Required, Time to Arrival, Cycle Time, Closure, Fleet Capability, Fleet Capacity, Airfield Throughput Capability (station capability), Aeromedical Evacuation Missions (number required per day), and Aeromedical Evacuation Crew (number required for missions flown) are airlift and aeromedical evacuation formulas that may be used by JOSAC long range flight planners. Many of these formulas use aircraft block speeds in their calculations. For example, Time to Arrival is calculated by summing the Active Route Flying Time (ARFT) and the Active Route Ground Time (ARGT). The formula for ARFT is given in Equation 1.

$$ARFT = \left(\frac{Dist_1}{Block\ Speed_1}\right) + \left(\frac{Dist_2}{Block\ Speed_2}\right) + \left(\frac{Dist_3}{Block\ Speed_3}\right) + \cdots \qquad 1$$

Thus, it is important that an accurate set of block speed data exists that flight planners can quickly reference for calculations made in these initial stages of mission planning (HQ AMC/A3XP, 2011).

Block Speed in the Global Air Mobility System

Many of today's defense transportation models that deal with airlift make use of fundamental algebraic relationships that characterize the movement of cargo and passengers. With these relationships and appropriate planning factors, calculations can be made that are vital to the military transportation system. One important calculation, and the focus of this research, is aircraft block speed. Block speed is defined as the leg distance divided by the total elapsed time, from aircraft brake release on takeoff to block-in (i.e., parking) after landing. The aircraft block speed computation is shown in Equation 2.

$$Block\ Speed\ (Kts) = \frac{Distance\ (NM)}{Total\ Elapsed\ Time\ (Hr)} \qquad 2$$

These calculations, relationships, and planning factors serve as the basis for conducting quick look assessments, what if analyses, and long range mission planning (Brigantic & Merrill, 2004).

As opposed to a model, the real world global air mobility system is highly complex. The simple calculations, relationships, and planning factors used by mobility flight planners imply perfect scheduling, an assumption that will never be actually achieved. Uncontrollable random variables within the transportation system result in constraints imposed upon the actual metrics being used. Using only these computed numbers for planning will tend to overestimate the true mobility capability of a system. For this reason, these calculations alone should not be used for flight planning close to mission execution. These planning factors should be used early in the mission planning process when mission specific parameters have yet to be defined (Brigantic & Merrill, 2004).

Linear Regression

Linear regression is a mathematical technique whereby one variable is used to help predict the behavior of another. A line is fit to a set of data that best estimates the linear relationship between the observations. Much of the theory behind linear regression techniques is based upon the study of linear algebra. For example, the equation of a straight line is shown in Equation 3.

$$y = b + mx \tag{3}$$

In this equation, *b* denotes the y-intercept and *m* denotes the slope of the line. Similarly, the equation of a linear regression model is shown in Equation 4.

$$\bar{Y} = \beta_0 + \beta_1 x \tag{4}$$

In this equation, β_0 denotes the y-intercept and β_1 denotes the slope of the regression line (Milton & Arnold, 2003).

To estimate the regression line, a logical way to estimate the parameters β_0 and β_1 must first be found. To do this, the linear regression model must be rewritten in an alternative form. Each observation taken from the data set varies somewhat about its mean value. E_i denotes this random difference. A different way to express the linear regression model is with the addition of E_i and is depicted in Equation 5 (Milton & Arnold, 2003).

$$Y_i = \beta_0 + \beta_1 x_i + E_i \quad \textbf{5}$$

The data set consists of a collection of n pairs (x_i, y_i), where x_i is an observed value of the variable X and y_i is the corresponding observation for the random variable Y. The observed value of a random variable usually differs from its mean value by some random amount. This is shown in Equation 6.

$$y_i = \beta_0 + \beta_1 x_i + \varepsilon_i \quad \textbf{6}$$

In this equation, ε_i denotes a realization of the random variable E_i when Y_i takes on the value y_i. Then, by letting b_0 and b_1 denote the estimates of β_0 and β_1, respectively, and letting e_i denote the vertical distance from a point (x_i, y_i) to the estimated regression line, each data point satisfies Equation 7.

$$y_i = b_0 + b_1 x_i + e_i \quad \textbf{7}$$

The term e_i is called the residual. Thus, the residual is the vertical distance from the point (x_i, y_i) to the estimated regression line (Milton & Arnold, 2003).

Minimizing the sum of the squares of these residuals is a way to get the best fit of the regression line. This is called the method of least squares. This method essentially picks the line that comes as close as it can to all observations simultaneously. The residuals are squared before summing so that all negative residual values become positive. If the residuals themselves were summed (without squaring them), the negative and positive values of these residuals would counteract each other and their sum would equal zero (Milton & Arnold, 2003).

To determine how well the least squares line fits the data set, the coefficient of determination (R^2) should be examined. R^2 is the percentage of variation in y explained by *x* or by the fitted regression equation. It gives some information on the goodness-of-fit of the model. It shows how well the computed regression line approximates the actual data set. A high R^2 (values near 1) means that the linear relationship between *x* and *y* is strong, or that the model explains the data well (Winston, 2004).

A t-test may be used to test the significance of the linear relationship found in the data set. By comparing a computed t-statistic to the value found upon examination of the t-distribution at a specific level of significance (α), a conclusion can be drawn as to the strength of the linear relationship between *x* and *y*. The p-value can also be used for this analysis. For the intercept and slope of the model, the p-value gives the probability that the value taken from the t-distribution at a specific α is greater than or equal to the computed t-statistic. A p-value less than α means there is a significant linear relationship found in the data set (Winston, 2004).

An F-test may be used to test the appropriateness of the linear regression model. This is a statistical method for detecting model lack-of-fit based upon an examination of the residuals. The residual or error sum of squares can be split up into two components based upon to the sources of error. The portion attributable to natural variability is called pure error. The portion attributable to inappropriateness of the model is called error due to lack of fit. An F-test compares statistics based upon these two partitions. A conclusion can then be drawn as to the appropriateness of the linear regression model. An F-test significance value less than a specific α means the linear regression model is appropriate (Winston, 2004).

A value from the data set that appears far removed from the rest of the data set is called an outlier. Outliers may show up because they are legitimate observations whose values are simply unusually large or small. Or they may show up as the result of an error is measurement, poor data collection technique, or a mistake in recording or entering the data points. In this case, the outlier may be corrected or the data point may be dropped from the data set (Milton & Arnold, 2003).

III. Methodology

Overview

This chapter describes the origin of the data and provides an explanation of the method used to analyze the data.

Data Source

USTRANSCOM provided the data set from which all analysis was conducted. The data covered an almost five year period between May 2008 and April 2013 and included a total of 199,398 flights by 23 different types of OSA aircraft. The data was transcribed into a table like the one shown in Figure 1.

LEG_ID	DEPART_DTG	MSN_ID	ICAO_CODE	ARRIVAL_DTG	SEAT_CONFIG	SEAT_AVAL	CARGO_CONFIG	CARGO_AVAL	LEG_NUMBER	DISTANCE	TRUE_COURSE	GROUND_TIME	FLIGHT_TIME	MSN_TIME	SOFTPAX_CARGO	ACTY_TYPE	Detp ICAO	Arr ICAO
2149924	4/28/09 20:21	278831	KOZR	4/28/09 20:21	7	7	0	0	3	385	314.35	0	141	141	0	C12D	06FA	KOZR
2219371	9/17/09 21:01	284283	KLCK	9/17/09 20:16	7	7	550	550	4	256	53.3	45	76	121	0	C12D	K2I0	KLCK
2133346	3/24/09 20:50	277578	KCKB	3/24/09 20:50	7	7	410	410	4	573	8.48	0	182	182	0	C12D	K42J	KCKB
2133265	3/25/09 18:01	277572	KCRW	3/25/09 17:16	7	7	410	410	3	511	0	45	166	211	0	C12D	K42J	KCRW
2206814	8/25/09 20:19	283491	KCRW	8/25/09 19:34	7	7	410	410	4	511	0	45	154	199	0	C12D	K42J	KCRW
2213750	9/3/09 21:34	284053	KCRW	9/3/09 20:49	7	7	410	410	3	511	0	45	162	207	0	C12D	K42J	KCRW
2443575	1/30/11 17:48	304464	KNGU	1/30/11 17:03	7	7	410	410	3	456	34.28	45	133	178	0	C12D	K4J6	KNGU
2162982	5/27/09 3:32	279868	KTTN	5/27/09 3:32	7	7	0	0	4	658	27.97	0	198	198	0	C12D	K4J6	KTTN
2487878	4/29/11 22:11	308222	KOQU	4/29/11 22:11	7	7	0	0	6	139	127.92	0	40	40	0	C12D	K5B2	KOQU
2626390	7/6/12 22:58	322266	KHDC	7/6/12 22:58	8	8	0	0	4	487	101.08	0	140	185	0	C12D	KABI	KHDC
2624534	6/21/12 19:55	322042	KPOB	6/21/12 19:55	7	7	0	0	5	1355	89.7	0	355	415	0	C12D	KABQ	KPOB
2005329	6/11/08 19:00	266353	KDHN	6/11/08 16:08	7	6	0	0	4	65	258.83	172	25	197	0	C12D	KABY	KDHN
2494418	5/18/11 22:22	309008	KNCA	5/18/11 21:52	7	7	0	0	3	390	58.95	30	112	142	0	C12D	KABY	KNCA
2540098	9/23/11 19:25	313466	KNCA	9/23/11 18:55	7	7	0	0	3	390	58.95	30	115	145	0	C12D	KABY	KNCA
2019529	7/18/08 21:09	267733	KNGU	7/18/08 20:39	8	8	0	0	3	510	48.48	30	154	184	0	C12D	KABY	KNGU
2444305	1/28/11 0:41	304520	KOQU	1/28/11 0:41	7	7	0	0	4	865	45.71	0	235	235	0	C12D	KABY	KOQU
2151918	4/30/09 21:12	278922	KOZR	4/30/09 21:12	7	7	0	0	4	79	259.06	0	31	31	0	C12D	KABY	KOZR
2523266	8/3/11 23:58	311647	KOZR	8/3/11 23:58	7	7	0	0	11	79	259.06	0	27	27	0	C12D	KABY	KOZR
2385271	9/2/10 20:47	298705	KRDU	9/2/10 20:17	7	2	0	0	3	377	46.19	30	112	142	0	C12D	KABY	KRDU
2157913	5/8/09 15:57	279289	KVPS	5/8/09 15:27	7	6	0	0	3	135	242.19	30	52	82	0	C12D	KABY	KVPS
2392556	9/22/10 20:23	299433	KAUG	9/22/10 19:38	7	7	410	410	6	361	34.47	45	109	154	0	C12D	KACY	KAUG
2391655	9/20/10 19:57	299366	KBGR	9/20/10 19:57	7	7	410	410	4	411	36.6	0	122	122	0	C12D	KACY	KBGR
2006536	6/15/08 17:46	266476	KNSF	6/15/08 17:16	8	8	0	0	3	113	250.46	30	39	69	0	C12D	KACY	KNSF
2219370	9/17/09 19:00	284283	K2I0	9/17/09 17:35	7	0	550	550	3	504	263.23	85	185	270	0	C12D	KADW	K2I0
2291307	2/27/10 17:00	290549	KAEX	2/26/10 0:13	7	3	550	550	3	892	239.75	2447	313	2820	0	C12D	KADW	KAEX
2628988	7/18/12 23:18	322618	KAEX	7/18/12 22:48	8	8	0	0	3	892	239.75	30	287	377	0	C12D	KADW	KAEX
2700198	11/2/12 19:43	363684	KAEX	11/2/12 18:58	7	7	410	410	4	892	239.75	45	298	403	0	C12D	KADW	KAEX
2631892	7/25/12 19:00	322951	KAGS	7/25/12 14:00	7	5	0	0	3	410	217.11	300	145	445	0	C12D	KADW	KAGS
2177062	6/25/09 18:50	281016	KALB	6/25/09 18:20	7	7	0	0	3	274	30.63	30	84	114	0	C12D	KADW	KALB
2543766	9/30/11 19:45	313817	KALB	9/30/11 19:00	7	7	550	550	3	274	30.63	45	83	128	0	C12D	KADW	KALB
2543770	9/30/11 19:45	313818	KALB	9/30/11 19:00	7	7	550	550	3	274	30.63	45	83	128	0	C12D	KADW	KALB
2548836	10/17/11 20:09	314092	KBAD	10/17/11 19:24	7	2	410	110	3	908	245.32	45	304	409	0	C12D	KADW	KBAD
2236727	10/28/09 21:07	285965	KBAF	10/28/09 20:22	7	7	550	550	4	276	41.93	45	82	127	0	C12D	KADW	KBAF
2152764	4/30/09 23:37	278926	KBDL	4/30/09 23:07	7	7	0	0	6	268	45.88	30	78	108	0	C12D	KADW	KBDL
2159958	5/13/09 20:47	279390	KBDL	5/13/09 20:02	7	7	550	550	6	268	45.88	45	78	123	0	C12D	KADW	KBDL
2161969	5/21/09 20:34	279790	KBDL	5/21/09 19:58	7	7	0	0	4	268	45.88	36	78	114	0	C12D	KADW	KBDL
2205531	8/21/09 21:21	283340	KBDL	8/21/09 20:51	7	6	0	0	3	268	45.88	30	81	111	0	C12D	KADW	KBDL
2227344	10/7/09 22:04	285107	KBDL	10/7/09 21:19	7	2	550	550	3	268	45.88	45	79	124	0	C12D	KADW	KBDL
2227303	10/7/09 20:49	285123	KBDL	10/7/09 20:19	7	7	0	0	3	268	45.88	30	79	109	0	C12D	KADW	KBDL

Figure 1 - Data Source

Fields included in the data set were: Leg ID, Departure DTG (Date Time Group), Mission ID, ICAO (Airport) Code, Arrival DTG, Seat Configuration, Seat Availability, Cargo Configuration, Cargo Availability, Leg Number, Distance, True Course, Ground Time, Flight Time, Mission Time, Softpax Cargo, Aircraft Type, Departure ICAO, and Arrival ICAO. Not all of these fields were applicable to this study. Therefore, not all of these fields were used. Only the Leg ID, Departure DTG, Mission ID, Arrival DTG, Distance, True Course, Flight Time, Aircraft Type, Departure ICAO, and Arrival ICAO were used in the remainder of this study.

The data set for the 23 OSA aircraft was first sorted into 13 sub-groups based upon aircraft cruise speed. These cruise speeds were provided by USTRANSCOM. Several of the aircraft have identical cruise speeds and were subsequently grouped together. The 23 types of aircraft with their published cruise speeds are given in Table 1.

Table 1 - Aircraft With Cruise Speeds

ACFT_TYPE	CRUISE_SPEED_KTS
C12D	240
C12F	265
C12R	260
C12T	270
C12U	270
C12V	260
C130E	290
C20G	450
C21	440
C26B	265
C26E	265
C38	483
C40	450
C9B	440
DC9	440
UC12B	250
UC12F	250
UC12M	240
UC12W	250
UC35A	420
UC35B	420
UC35C	420
UC35D	420

The 13 sub-groups with their associated cruise speeds are given in Table 2.

Table 2 - Aircraft Sub-Groups With Cruise Speeds

ACFT_TYPE	CRUISE_SPEED_KTS
C130E	290
C20G	450
C21	440
C26B/E	265
C38	483
C40	450
C9B/DC9	440
UC35A/B/C/D	420
C12D/UC12M	240
C12F	265
C12R/V	260
C12T/U	270
UC12B/F/W	250

The data set for each of these sub-groups was further broken down by direction of flight. This was done through examination and by sorting the data by true course. Each of the 13 sub-groups was separated into three data sets: flights that traveled east, flights that traveled west, and all flights combined together.

Data Sorting

For purposes of brevity, the remainder of this methodology will focus on one aircraft sub-group, UC35A/B/C/D. The UC35A/B/C/D data set consists of 19,250 observations. It was separated into three groups that will be referred to as UC35A/B/C/D East, West, and All. The UC35A/B/C/D East data set (9,507 observations) was transcribed into a table like the one shown in Figure 2.

LEG_ID	MSN_ID	DISTANCE	TRUE_COURSE	GROUND_TIME	FLIGHT_TIME	MSN_TIME	ACTY_TYPE	Detp ICAO	Arr ICAO
2232212	285466	95	11.73	0	33	33	UC35A	KRND	KGRK
2231673	285550	95	11.73	0	33	33	UC35A	KRND	KGRK
2544396	313763	95	11.73	0	34	34	UC35A	KRND	KGRK
2547904	314221	95	11.73	0	34	34	UC35A	KRND	KGRK
2686928	354724	95	11.73	0	36	36	UC35A	KRND	KGRK
2691084	357424	95	11.73	0	36	36	UC35A	KRND	KGRK
2691163	357504	95	11.73	0	36	36	UC35A	KRND	KGRK
2691243	357584	95	11.73	0	36	36	UC35A	KRND	KGRK
2561736	315482	220	11.95	60	43	103	UC35D	KNCA	KNHK
2458492	305692	782	11.98	60	152	212	UC35A	KFLL	KADW
2510003	310381	219	12.03	783	42	825	UC35D	KNRB	KSSC
2620633	321777	278	12.14	30	54	84	UC35A	KPOB	KHGR
2045552	269781	578	12.33	102	113	215	UC35D	KHRT	KFFO
2328233	293640	578	12.33	60	113	173	UC35D	KHRT	KFFO
2523030	311619	484	12.36	600	107	707	UC35D	KGRK	KFOE
2150715	278884	86	12.38	0	25	25	UC35B	KCSG	KMGE
2426426	302729	86	12.38	0	25	25	UC35B	KCSG	KMGE
2352346	295648	800	12.44	60	153	213	UC35C	KMIA	KADW
2034229	268951	800	12.44	60	154	214	UC35A	KMIA	KADW
2247589	286755	800	12.44	60	155	215	UC35A	KMIA	KADW
2106551	275353	800	12.44	60	155	215	UC35D	KMIA	KADW

Figure 2 - UC35A/B/C/D East Data Set

The UC35A/B/C/D West data set (9,743 observations) and the UC35A/B/C/D All data set (19,250 observations) were transcribed into similar tables. However, the remainder of this chapter will examine only on the UC35A/B/C/D East data set. All other calculations for this and all other aircraft sub-groups were similarly computed before they were analyzed.

Next, a pivot table was created using the UC35A/B/C/D East data set and the distance and flight time fields. The average flight time for each distance observation in the data set was computed. This distance and average flight time were sorted and summarized in a pivot table like the one shown in Figure 3.

Dist	Time
128	25.0
129	26.4
130	25.0
131	30.4
132	25.0
133	25.9
134	25.0
135	25.9
136	25.2
137	25.0
138	60.0
139	27.5
140	27.0
141	26.2
142	26.5
143	28.0
144	28.6
145	27.0
146	27.0
147	28.5
148	29.0

Figure 3 - Distance vs. Time

The speed for each distance and average flight time pairing was then calculated using the formula given in Equation 8.

$$Speed\ (Kts) = \frac{Distance\ (NM)}{\left[\frac{Time\ (min)}{60\ \left(\frac{min}{hr}\right)}\right]} \qquad \mathbf{8}$$

The resultant speeds are shown in a table similar to the one in Figure 4 .

Speed	Dist	Time
307.2	128	25.0
292.7	129	26.4
312.0	130	25.0
258.4	131	30.4
316.8	132	25.0
308.1	133	25.9
321.6	134	25.0
312.8	135	25.9
323.8	136	25.2
328.8	137	25.0
138.0	138	60.0
303.3	139	27.5
311.1	140	27.0
323.3	141	26.2
321.0	142	26.5
306.4	143	28.0
301.7	144	28.6
322.6	145	27.0
324.4	146	27.0
309.5	147	28.5
306.2	148	29.0

Figure 4 - Speed vs. Distance

Fitting a Line

The calculated speed versus distance was then regressed and a linear regression model was created. The summary output of the regression and ANOVA (Analysis of Variance) table, displayed in Figure 5, was then analyzed.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.664433217
R Square	0.441471499
Adjusted R Square	0.441051553
Standard Error	41.83271131
Observations	1332

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1839674.549	1839674.549	1051.257176	2.0055E-170
Residual	1330	2327467.728	1749.975735		
Total	1331	4167142.277			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	267.5999777	2.056155489	130.1457887	0	263.5663164	271.6336391	263.5663164	271.6336391
Dist	0.06846073	0.00211148	32.42309633	2.0055E-170	0.064318535	0.072602925	0.064318535	0.072602925

Figure 5 - UC35A/B/C/D East ANOVA Table (Initial)

The summary output shows that the model has an F-test significance value of $2 * e^{-170}$ or 0. Because this value is less than α = 0.05, we can say that the linear regression model is appropriate. It also shows that the model has a R^2 of 0.44. So approximately 44% of the variation in the model is explained by the fitted regression equation or the regression line (Predicted Speed). Finally, the summary output shows that the model has a p-value of $2 * e^{-170}$ or 0. Because this p-value is less than α = 0.05, we can say that there is a significant linear relationship found in the data set.

Data Cleaning

The Line Fit Plot (Figure 6) and Residual Plot (Figure 7) were then analyzed.

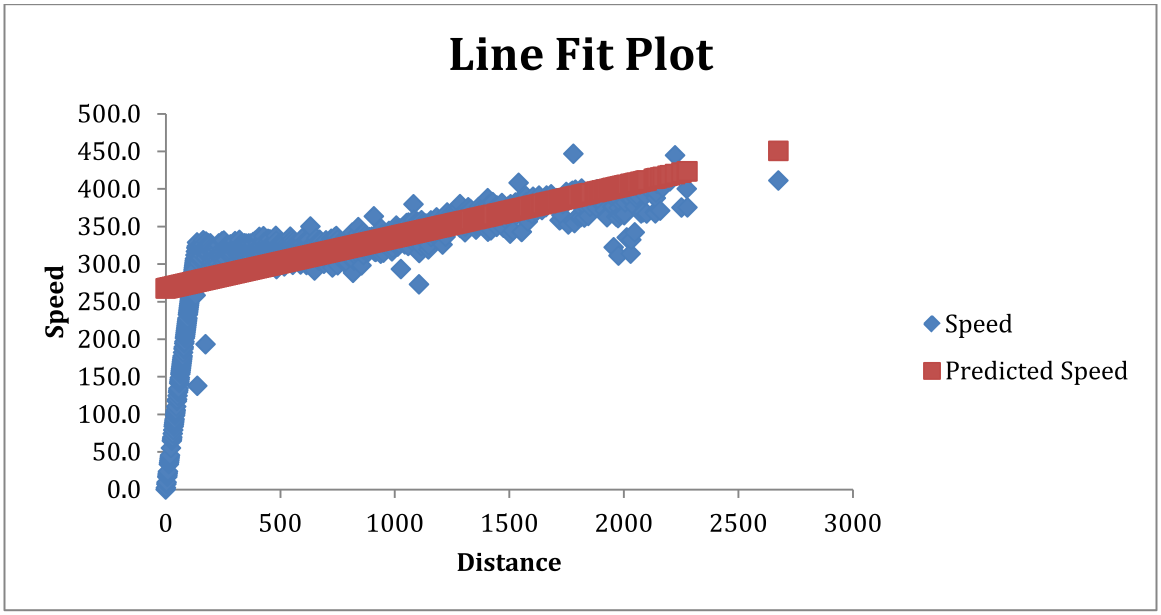

Figure 6 - UC35A/B/C/D East Line Fit Plot (Initial)

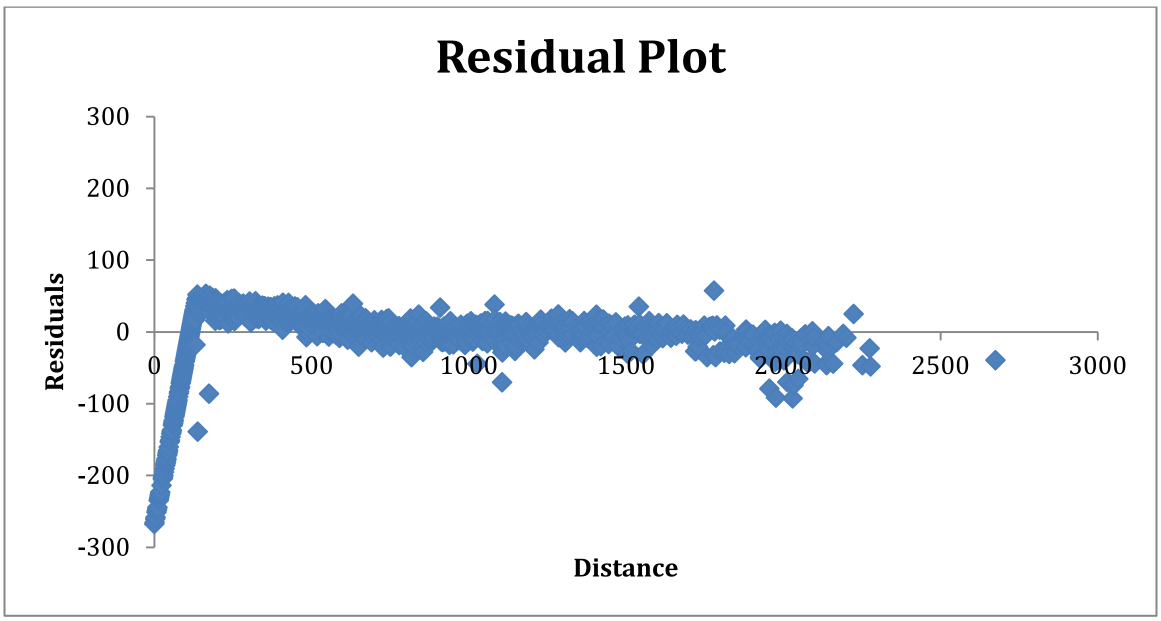

Figure 7 - UC35A/B/C/D East Residual Plot (Initial)

Based upon an initial inspection of the plots, the UC35A/B/C/D East data set appeared to contain several invalid data points. For example, several flights existed that had the same Departure and Arrival ICAOs. These points had flight times of 0 or 1 minute and distances of 1 or 3 NMs. In actuality, there were no 0 minute flights that traveled 1 mile. These points were most likely entered in error. Thus, they were not valid for purposes of this study and were thrown out. Similarly, JOSAC/USTRANSCOM standard practice is to input a value of 25 minutes into the Flight Time field of the database for all flights less than or equal to 25 minutes. Since they are not valid time and distance combinations, these points with flight times of 25 minutes or less serve no useful purpose to this study. They were therefore thrown out as well. Examples of these can be seen in Figure 8, Figure 9, and Figure 10.

LEG_ID	MSN_ID	DISTANCE	TRUE_COURSE	GROUND_TIME	FLIGHT_TIME	MSN_TIME	ACTY_TYPE	Detp ICAO	Arr ICAO
2130366	277113	1	89.93	60	0	60	UC35D	KNSF	KADW
2402595	300008	3	89.97	128	1	129	UC35A	KLFI	KLFI
2402522	300293	3	89.97	87	1	88	UC35D	KADW	KADW
2441396	304211	4	89.97	60	1	61	UC35D	KNKT	KNKT
2303124	291437	98	11.53	0	6	6	UC35B	KLSF	KMGE
2070063	271956	27	44.68	720	15	735	UC35D	KNYG	KADW
2046684	269883	37	83.23	0	15	15	UC35D	KOAJ	KNKT
2251335	286867	105	159.57	35	24	59	UC35A	KDAA	KLFI
2140056	277940	52	0	97	25	122	UC35A	KOQU	KBED
2274263	289143	73	0	0	25	25	UC35A	KRIC	KDAA
2612617	320864	73	0	0	25	25	UC35A	KRIC	KDAA
2612981	321007	73	0	0	25	25	UC35A	KRIC	KDAA
2614491	321147	82	0	60	25	85	UC35C	KADW	KMDT
2399330	300056	84	0	60	25	85	UC35D	KADW	KCXY
2621138	321819	84	0	60	25	85	UC35D	KADW	KCXY
2189393	282140	82	0	60	25	85	UC35D	KADW	KMDT
2206102	283417	82	0	60	25	85	UC35D	KADW	KMDT
2291591	290607	82	0	60	25	85	UC35D	KADW	KMDT
2520272	311475	82	0	60	25	85	UC35D	KADW	KMDT

Figure 8 - UC35A/B/C/D East Data Set (Invalid Points)

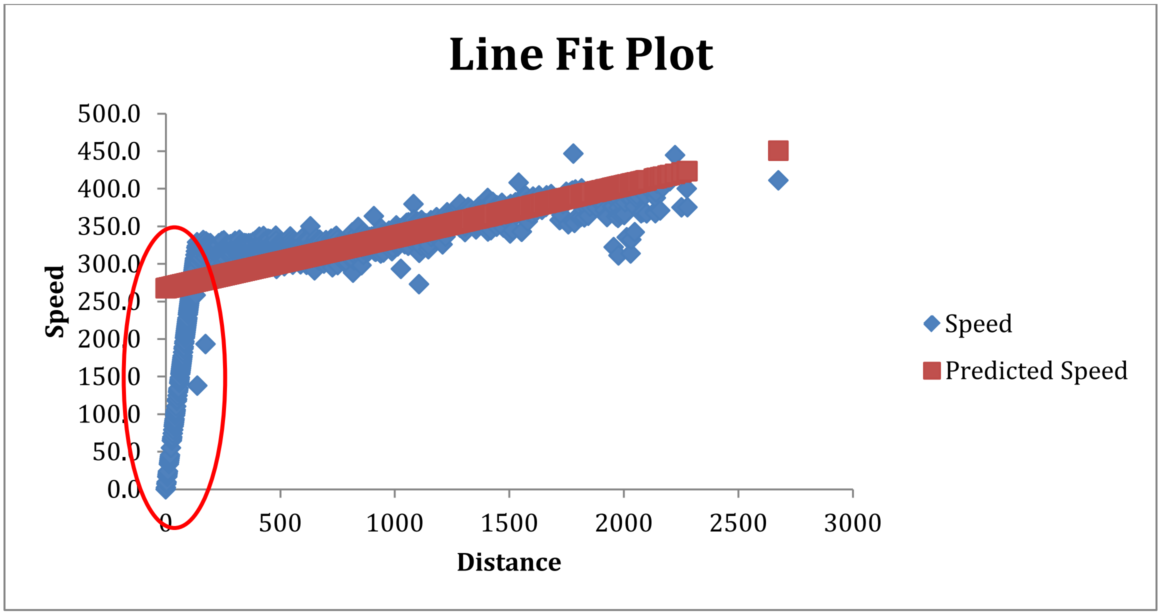

Figure 9 - UC35A/B/C/D East Line Fit Plot (Invalid Points)

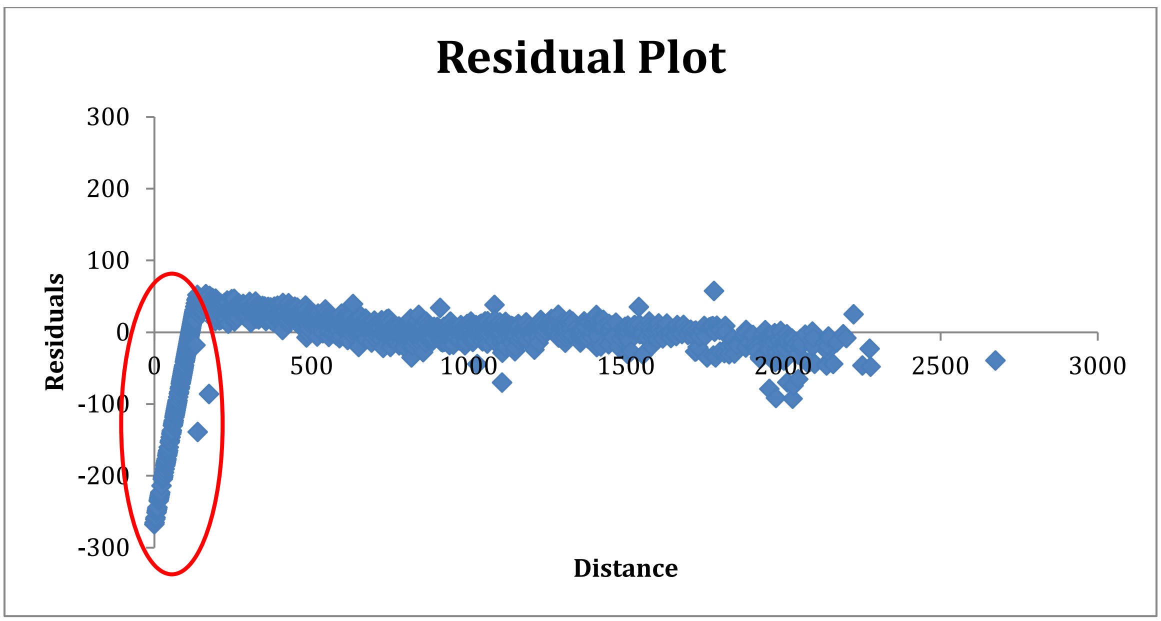

Figure 10 - UC35A/B/C/D East Residual Plot (Invalid Points)

Based upon an initial visual inspection of the plots, the UC35A/B/C/D East data set appeared to contain several outliers as well. For example, the data point with a distance of 2,675 NMs and a speed of 411.3 Kts looked to be an outlier. The single point used to populate the plots was built from four flights, each with a distance of 2,675 NMs. This distance was over 400 NMs further than the next closest observation. In fact, this distance is well beyond the range of the aircraft. Most likely, these missions were flown with a fuel stop in between the Departure and Arrival ICAOs. Because there is no way to know what the correct time and distance combination actually was for these points, they were discarded. This is shown in Figure 11, Figure 12, and Figure 13.

LEG_ID	MSN_ID	DISTANCE	TRUE_COURSE	GROUND_TIME	FLIGHT_TIME	MSN_TIME	ACTY_TYPE	Detp ICAO	Arr ICAO
2284729	289833	2675	67.72	604	386	1020	UC35D	KNZY	KADW
2431651	303221	2675	67.72	0	386	446	UC35D	KNZY	KADW
2464144	306261	2675	67.72	0	391	421	UC35D	KNZY	KADW
2551959	314597	2675	67.72	0	398	428	UC35D	KNZY	KADW

Figure 11 - UC35A/B/C/D East Data Set (Outliers)

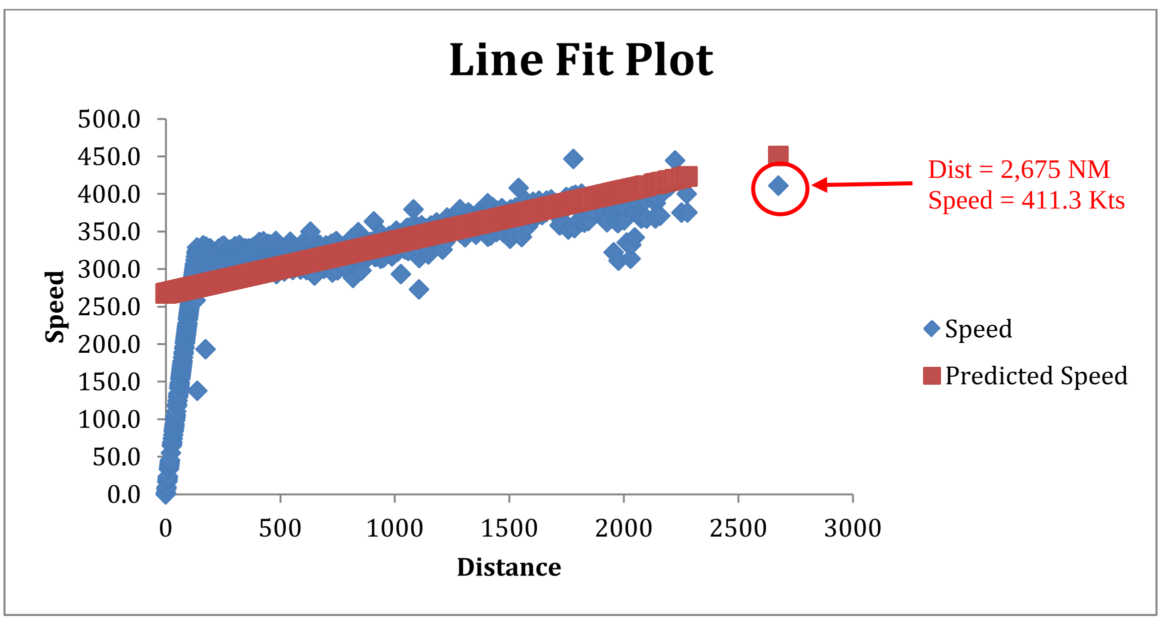

Figure 12 - UC35A/B/C/D East Line Fit Plot (Outliers)

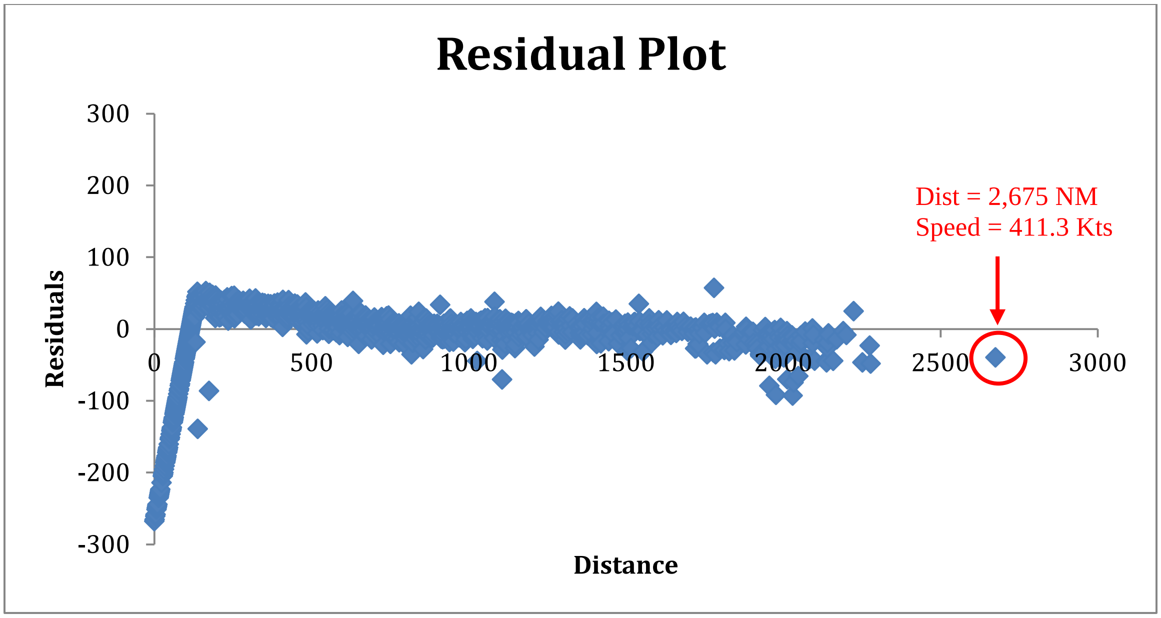

Figure 13 - UC35A/B/C/D East Residual Plot (Outliers)

This process of data cleaning and removing or fixing all the invalid data points and outliers was repeated until all that remained in the data set were valid flights. Once the UC35A/B/C/D East data set was cleaned, the process of creating a pivot table, calculating the speed, regressing the data, and analyzing the output was repeated. A final UC35A/B/C/D East regression model was created. The results of this process are seen in Figure 14, Figure 15, and Figure 16.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.798245044
R Square	0.637195151
Adjusted R Square	0.636900905
Standard Error	17.91470807
Observations	1235

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	694995.394	694995.394	2165.521279	9.8286E-274
Residual	1233	395715.0314	320.9367651		
Total	1234	1090710.425			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	294.5224925	0.990023574	297.4903833	0	292.5801753	296.4648096	292.5801753	296.4648096
Dist	0.045786344	0.000983909	46.53516175	9.8286E-274	0.043856024	0.047716664	0.043856024	0.047716664

Figure 14 - UC35A/B/C/D East ANOVA Table (Final)

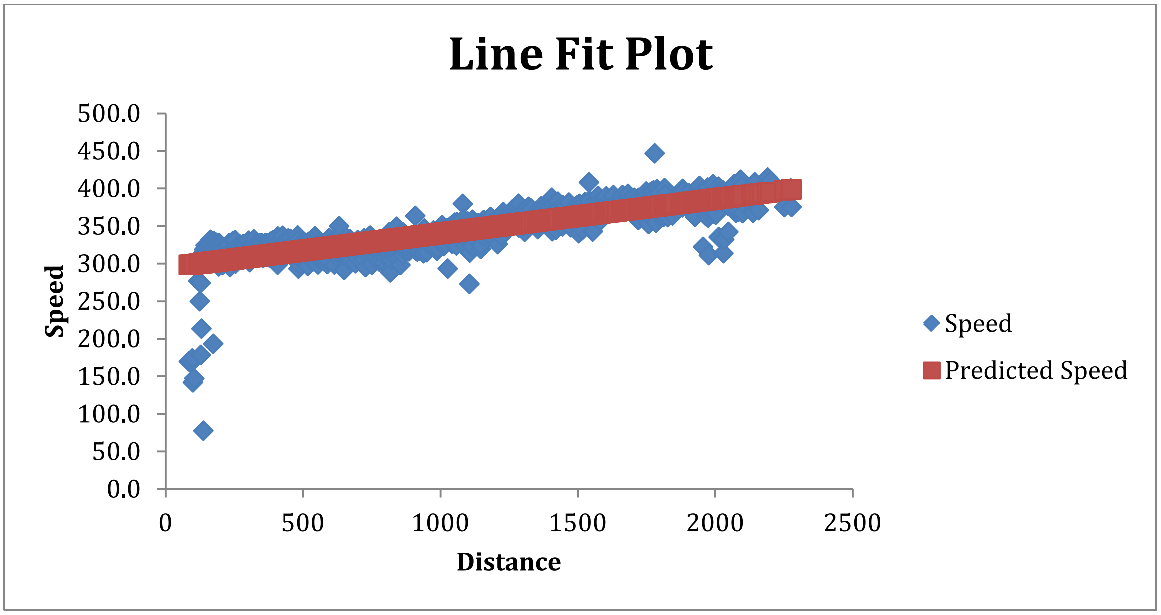

Figure 15 - UC35A/B/C/D East Line Fit Plot (Final)

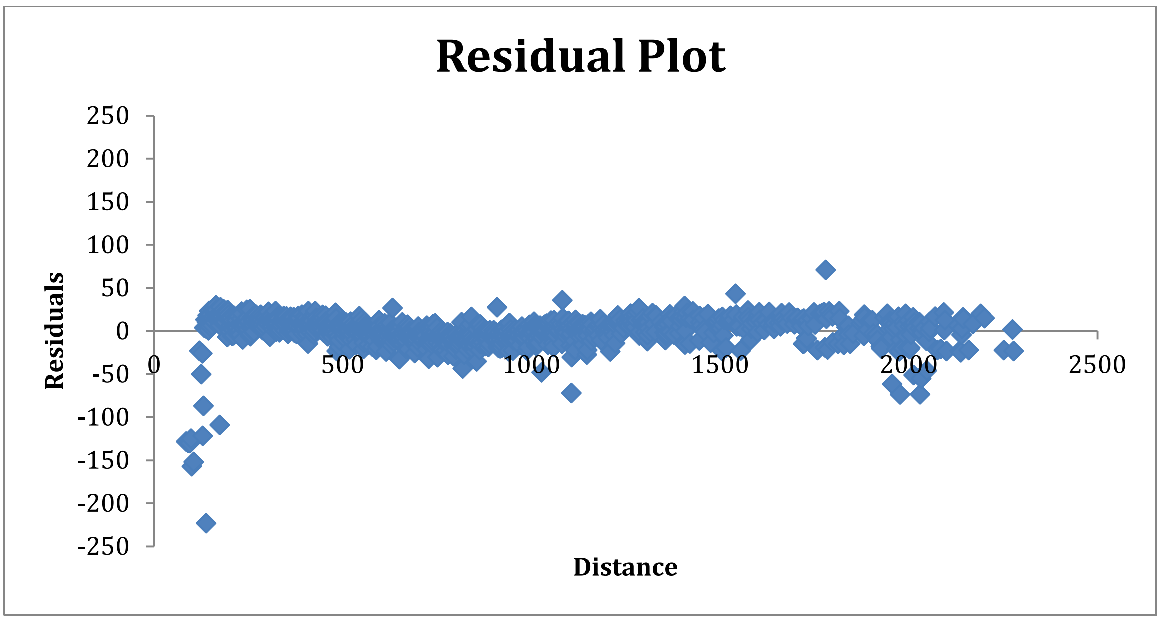

Figure 16 - UC35A/B/C/D East Residual Plot (Final)

As seen in the plots, what appear to be outliers or invalid points still show up at distances less than approximately 250 NMs. However, these flights were investigated and deemed to be valid. They are legitimate observations whose values are simply small. Outside of these points, the variance in the residuals appears to be relatively constant.

As seen in Figure 14, the summary output shows that the new model has an F-test significance value of $9.82 * e^{-274}$ or 0. Because this value is less than α = 0.05, we can say that the linear regression model is appropriate. The summary output also shows that the R^2 of the new model increased from 0.44 to 0.64. So approximately 64% of the variation in the model is explained by the fitted regression equation or the regression line (Predicted Speed). This new model provides a better goodness-of-fit than did the previous model. The summary output also shows that the model has a p-value of $9.82 * e^{-274}$ or 0. Because this p-value is less than α = 0.05, we can say that there is a significant linear relationship found in the data set. This new model appears to explain the data well.

Regression Equation

Through examination of the summary output, the coefficients of the regression equation (rounded to 294.52 and 0.05) were found. See Figure 17.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.798245044
R Square	0.637195151
Adjusted R Square	0.636900905
Standard Error	17.91470807
Observations	1235

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	694995.394	694995.394	2165.521279	9.8286E-274
Residual	1233	395715.0314	320.9367651		
Total	1234	1090710.425			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	294.5224925	0.990023574	297.4903833	0	292.5801753	296.4648096	292.5801753	296.4648096
Dist	0.045786344	0.000983909	46.53516175	9.8286E-274	0.043856024	0.047716664	0.043856024	0.047716664

Figure 17 - UC35A/B/C/D East ANOVA Table (Final)

The final regression equation could now be written (Equation 9). This equation comes as close as possible, using the method of least squares, to all the observations simultaneously.

$$y_i = 294.52 + 0.05x_i \qquad \textbf{9}$$

This equation could then be used to calculate a predicted block speed for any specific flight distance desired. A table was created using the regression equation to predict the block speed for a series of distances ranging from 250 NMs to 2,750 NMs in intervals of 250 NMs. This table of block speeds can be seen in Table 3.

Table 3 - UC35A/B/C/D East Block Speeds

Dist	Speed
250	306
500	317
750	329
1000	340
1250	352
1500	363
1750	375
2000	386
2250	398
2500	409
2750	420

Repeat Calculations

These calculations, and the analysis that followed, were then repeated for the UC35A/B/C/D West and All data. Regression equations were found and block speed tables were created. Finally, this entire process, from data sorting to calculating the block speeds, was repeated for the remainder of the 13 aircraft groups.

IV. Analysis

Block Speed Tables

Final block speed tables were compiled for aircraft flying East, flying West, and flying any direction. Mission planners should make the final decision as to which table is most appropriate for their use. Final block speed tables for all 13 aircraft sub-groups are displayed in Table 4, Table 5, and Table 6.

Table 4 - Block Speeds (East)

EAST

Type	Cruise	250nm	500nm	750nm	1000nm	1250nm	1500nm	1750nm	2000nm	2250nm	2500nm	2750nm
C130E	290	276	277	279	281	283	-	-	-	-	-	-
C20G	450	328	340	352	363	375	387	398	410	422	-	-
C21	440	320	332	343	354	365	377	388	399	410	-	-
C26B/E	265	237	241	245	248	252	256	260	264	268	-	-
C38	483	354	364	374	385	395	405	415	425	436	-	-
C40	450	330	342	353	365	377	389	401	413	425	-	-
C9B/DC9	440	378	382	386	391	395	399	404	408	412	417	421
UC35A/B/C/D	420	306	317	329	340	352	363	375	386	397	409	-
C12D/UC12M	240	197	205	213	222	230	238	246	254	262	-	-
C12F	265	218	225	233	241	249	257	264	272	280	-	-
C12R/V	260	204	212	221	229	237	246	254	262	271	-	-
C12T/U	270	237	242	248	253	259	264	270	275	281	287	-
UC12B/F/W	250	203	212	220	228	236	245	253	261	270	-	-

Table 5 - Block Speeds (West)

WEST

Type	Cruise	250nm	500nm	750nm	1000nm	1250nm	1500nm	1750nm	2000nm	2250nm	2500nm	2750nm
C130E	290	212	209	206	202	199	-	-	-	-	-	-
C20G	450	299	306	314	322	330	338	346	354	362	-	-
C21	440	288	297	306	315	323	332	341	350	359	-	-
C26B/E	265	201	201	201	202	202	202	202	202	203	-	-
C38	483	319	327	334	342	349	357	364	372	379	-	-
C40	450	294	304	314	323	333	343	352	362	371	-	-
C9B/DC9	440	338	339	340	341	342	344	345	346	347	349	350
UC35A/B/C/D	420	274	282	291	299	308	317	325	334	342	351	-
C12D/UC12M	240	166	171	176	181	187	192	197	203	208	-	-
C12F	265	182	187	191	196	201	205	210	215	219	-	-
C12R/V	260	171	176	181	186	191	196	201	206	210	-	-
C12T/U	270	201	202	203	204	206	207	208	209	210	211	-
UC12B/F/W	250	173	178	182	187	192	196	201	206	210	-	-

Table 6 - Block Speeds (All)

All												
Type	Cruise	250nm	500nm	750nm	1000nm	1250nm	1500nm	1750nm	2000nm	2250nm	2500nm	2750nm
C130E	290	224	232	240	248	256	-	-	-	-	-	-
C20G	450	313	323	333	343	353	363	373	383	393	-	-
C21	440	301	312	323	334	344	355	366	377	387	-	-
C26B/E	265	216	219	221	224	226	229	231	234	237	-	-
C38	483	336	345	354	363	372	380	389	398	407	-	-
C40	450	314	324	335	345	356	366	377	387	398	-	-
C9B/DC9	440	355	358	361	364	367	370	373	376	379	382	385
UC35A/B/C/D	420	288	298	309	319	329	339	349	359	370	380	-
C12D/UC12M	240	179	186	194	201	208	216	223	230	238	-	-
C12F	265	197	204	211	218	226	233	240	248	255	-	-
C12R/V	260	185	193	201	208	216	224	232	239	247	-	-
C12T/U	270	216	220	224	227	231	235	239	243	247	251	-
UC12B/F/W	250	186	193	200	207	214	221	228	235	242	-	-

With the exception of one aircraft (C130E), all block speeds increase as the distance increases and all block speeds appear to make sense. The suspect block speeds of the C130E may be due to the limited number of C130E observations used in this study. There were only 32 C130E observations in the data set, by far the fewest of any aircraft.

Regression Statistics

F-test significance values from all final computed regression models are displayed in Table 7.

Table 7 - F-Test

F-Test Significance Values

Type	East	West	All
C130E	0.63	0.31	0.21
C20G	1.6E-100	5.1E-70	1.6E-69
C21	5.9E-191	3.0E-193	1.3E-208
C26B/E	1.2E-72	2.4E-01	4.6E-17
C38	2.6E-68	7.8E-53	6.2E-49
C40	7.1E-50	6.4E-39	1.8E-41
C9B/DC9	7.4E-49	4.4E-07	1.9E-23
UC35A/B/C/D	9.8E-274	3.6E-256	1.3E-274
C12D/UC12M	4.8E-88	3.9E-49	1.5E-68
C12F	7.0E-127	3.6E-71	7.3E-93
C12R/V	2.2E-97	3.7E-47	9.9E-77
C12T/U	9.1E-113	3.1E-15	6.5E-56
UC12B/F/W	9.0E-89	6.7E-53	3.3E-70

Analysis of all 13 sub-groups showed that with the exception of one aircraft (C130E), all F-test significance values were less than $\alpha = 0.05$. Thus, we can say that the linear regression model is appropriate. The high F-test significance values of the C130E may be due to the limited number of C130E observations used in this study. Again, there were only 32 C130E observations in the data set, by far the fewest of any aircraft.

Some of the models do a good job of explaining the percentage of variation in the data. These models have relatively high R^2 values. The linear relationship between block speeds and distances in these models is strong. For the other models, not much of the variation in the data is explained by this relationship. Thus, there was very little change in block speed for each change in unit of distance.

Knowing the block speed for each of these sub-groups, which the analysis identified, should provide adequate information regardless of distance. For example, the block speeds for the sub-group with the smallest R^2, C26B/E West, differ by only 2 Kts throughout the entire range of distances (201 Kts vs. 203 Kts). So regardless of distance, using a block speed of 201 Kts or 203 Kts in flight planning calculations should provide very similar results. Attempting to explain the variance in the data was not one of the objectives of this research. Checking for the appropriateness of the linear regression model was. Overall, the linear regression model remains appropriate.

Model Accuracy

Similar aircraft flight profiles were plugged into commercial flight planning software. Multiple distance and direction combinations were employed. Use of this software yielded similar results to those computed from the tables in this study. The computed block speed tables appear to accurately model the flight profiles of these OSA aircraft.

V. Conclusion

Almost 200,000 flights, flown by 23 different OSA aircraft, were examined in this study. A linear regression equation predicting speed versus distance for each aircraft sub-group was determined. Regression statistics for each of these sub-groups were analyzed. Overall, the linear regression models did a good job of replicating the data observations and the models were deemed appropriate for use. Ultimately, aircraft block speed tables for these OSA aircraft were constructed.

Future research in this area should include using inputs other than distance to construct a linear regression model. Examination using actual course flown instead of simply East versus West could explain more of the variance in the data. For example, calculated aircraft block speeds may differ greatly for aircraft flying on a 010° true course versus a 090° true course. Detailed inspection of the departure and arrival airfields could explain more of the variance as well. For example, aircraft flying to/from dense, high traffic airfields may spend more time covering a similar distance than aircraft flying to/from smaller, low volume airfields due to routing and airspeed restrictions.

Future research should also include an examination of what may happen to each model's R^2 if more of the low flight time observations were removed from the data set. These observations were deemed valid, but their removal may ultimately provide a more precise model. In addition, it should include whether or not different linear regression equations should be used for different distance ranges. A model's regression equation for distances between 0 and 250 NMs may differ significantly from a model's regression equation for distances between 2,000 and 2,250 NMs. Finally, actual JOSAC computer flight plans (CFPs) should be crosschecked to ensure these block speed tables continue to accurately model the data. Remember, however, that these block speed tables simply provide a long range planning tool and should not be used for short term mission planning. As such, CFP numbers will not identically match those provided by these block speed tables.

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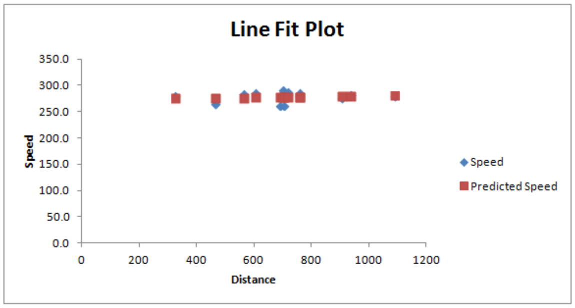
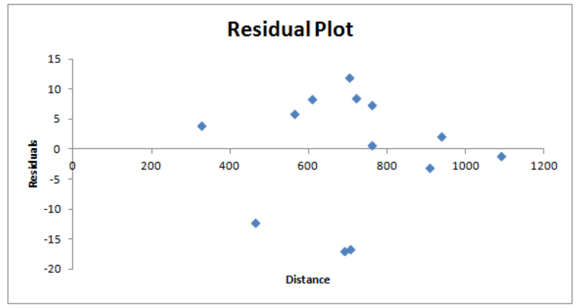
Appendix I

Regression Plots

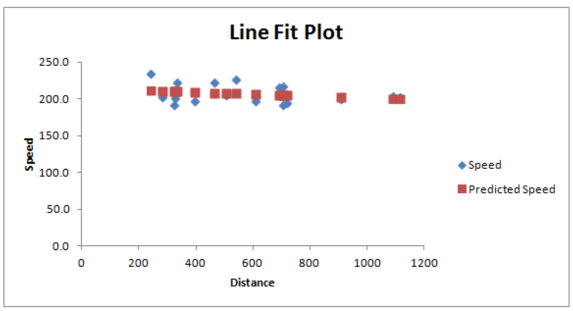
All final Line Fit Plots and Residual Plots are shown in Figure 18 to Figure 30.



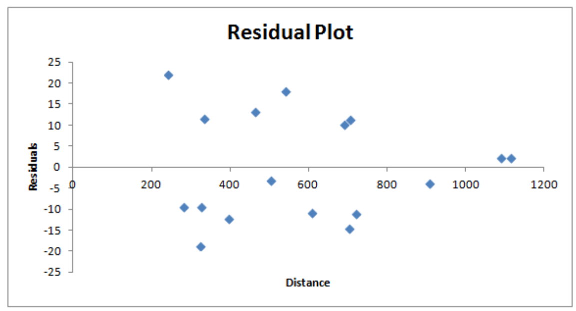
C130E East



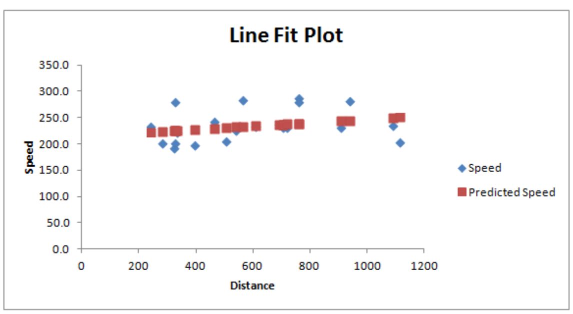
C130E East



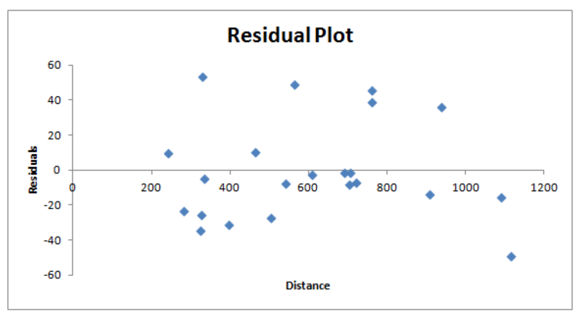
C130E West



C130E West

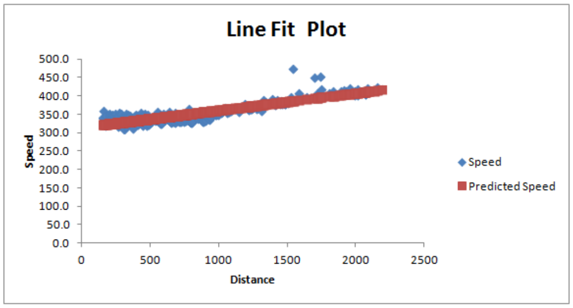


C130E All

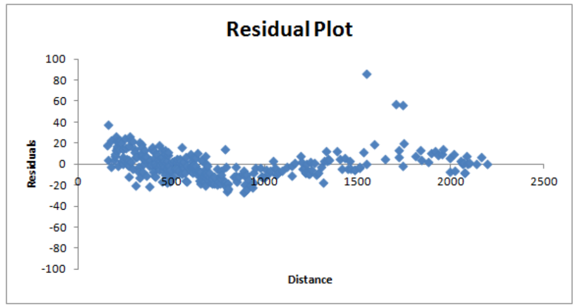


C130E All

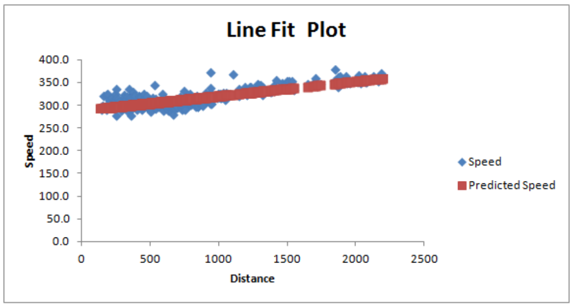
Figure 18 - C130E Plots



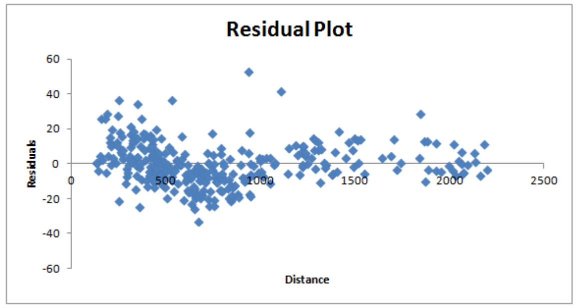
C20G East



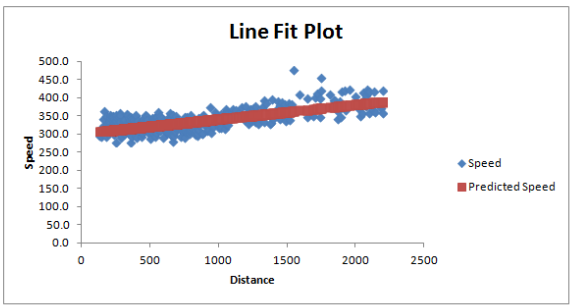
C20G East



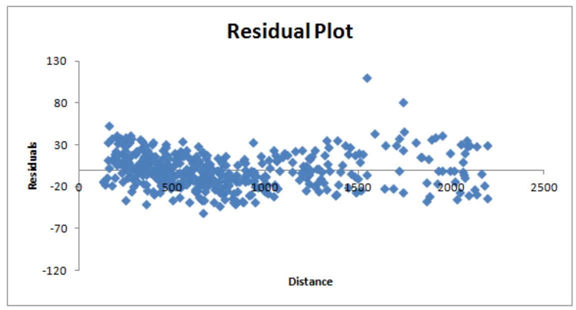
C20G West



C20G West

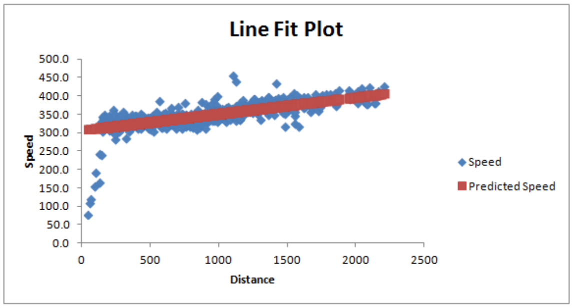


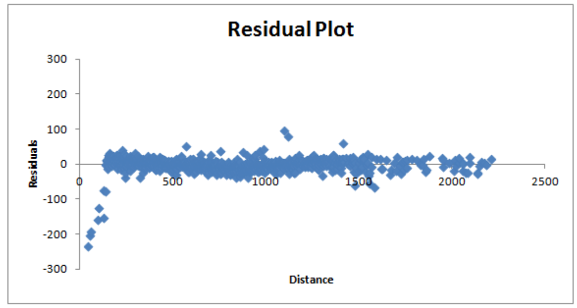
C20G All



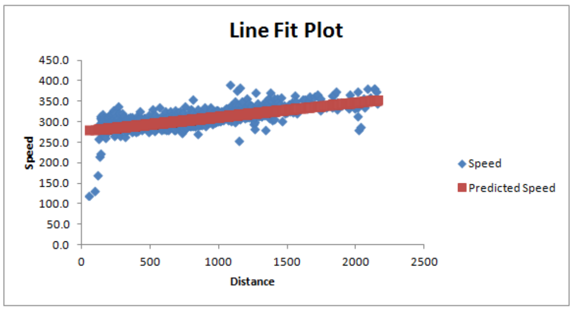
C20G All

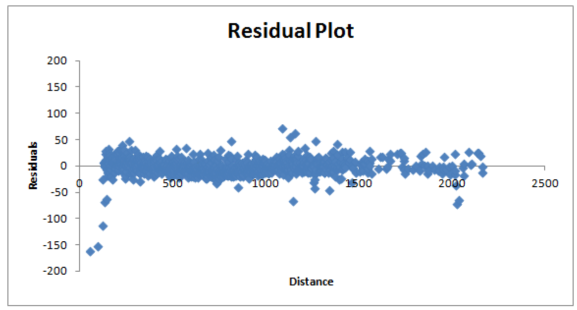
Figure 19 - C20G Plots



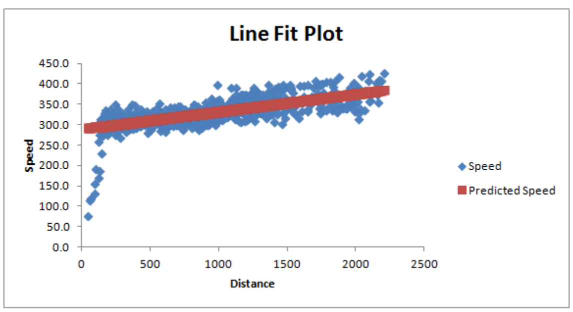


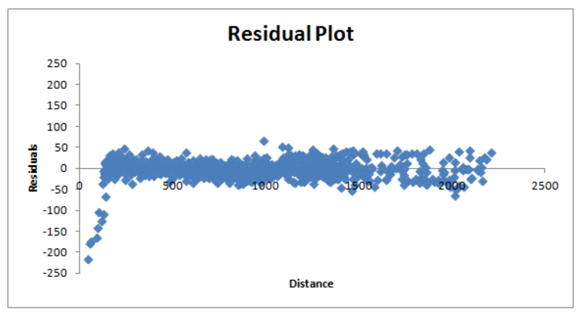
C21 East C21 East





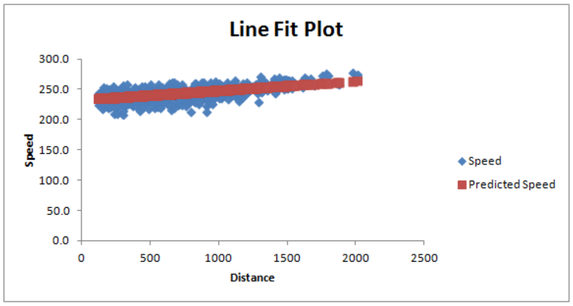
C21 West C21 West



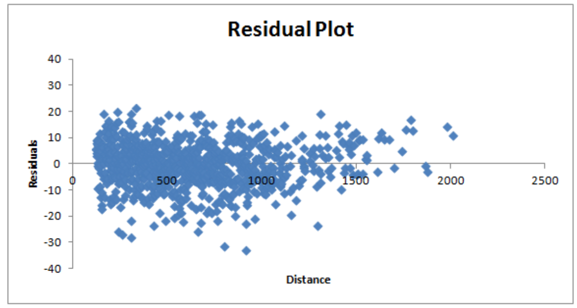


C21 All C21 All

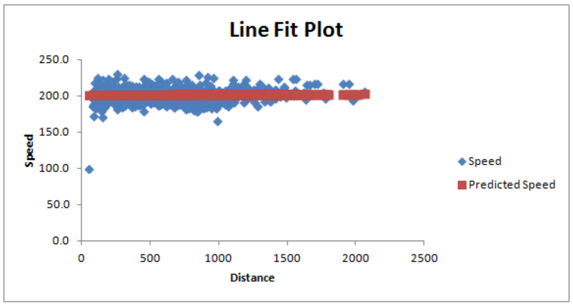
Figure 20 - C21 Plots



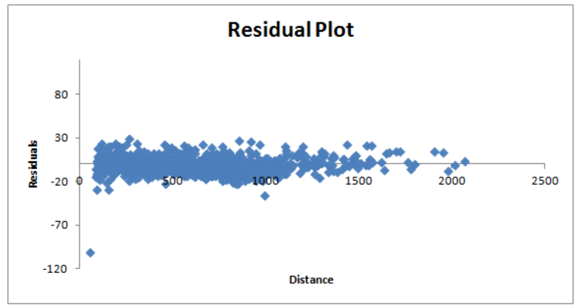
C26B/E East



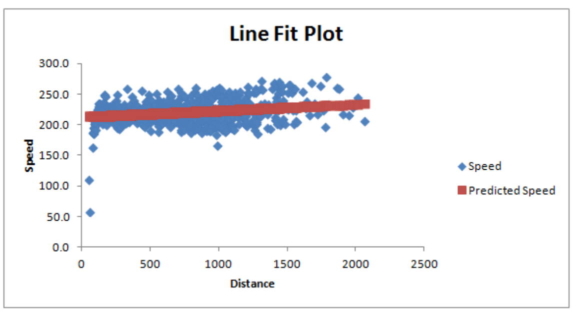
C26B/E East



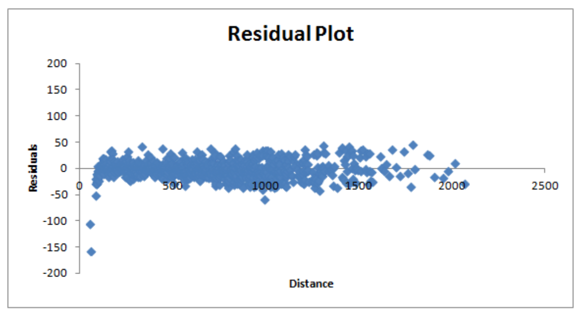
C26B/E West



C26B/E West

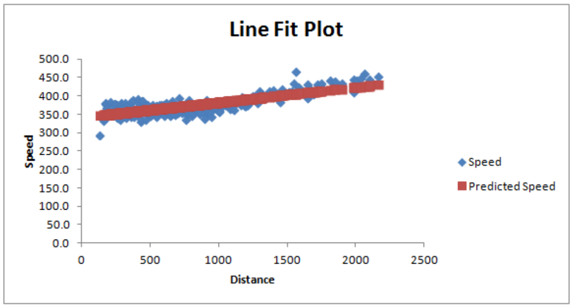


C26B/E All

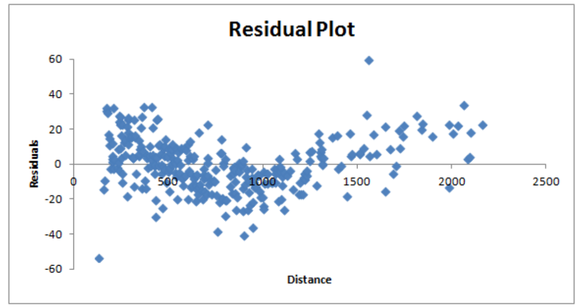


C26B/E All

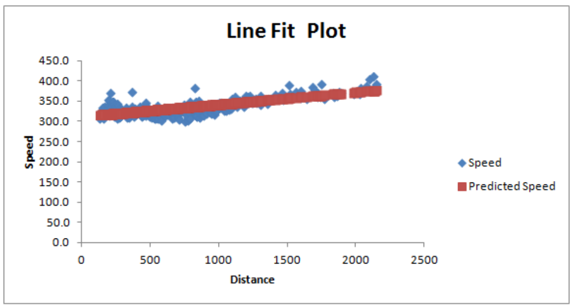
Figure 21 - C26B/E Plots



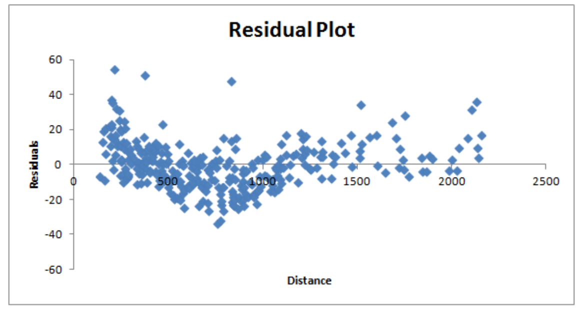
C38 East



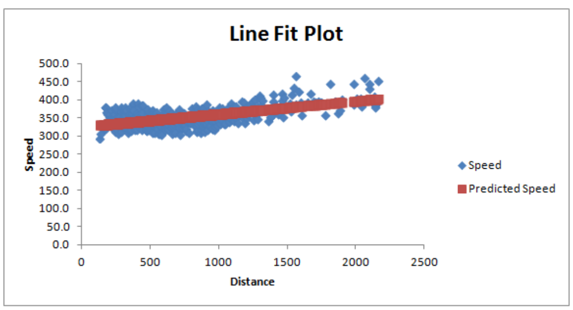
C38 East



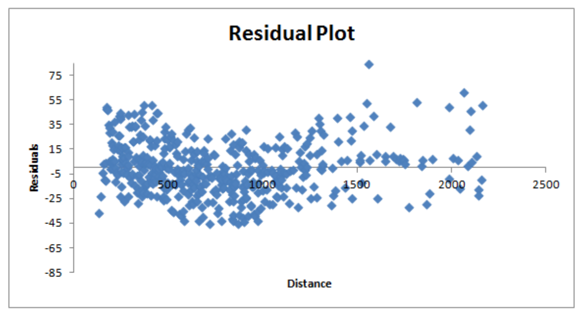
C38 West



C38 West

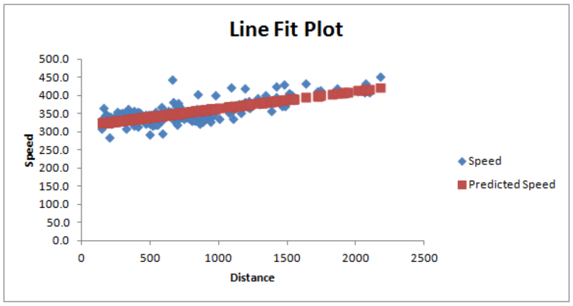


C38 All

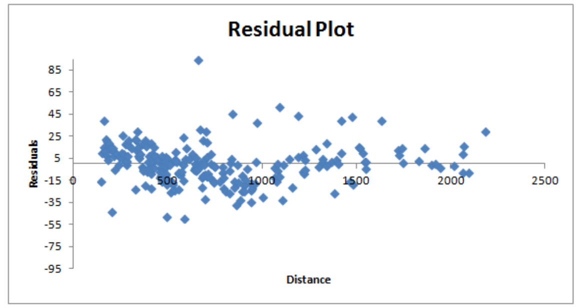


C38 All

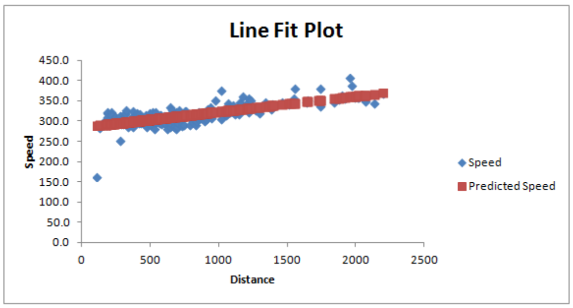
Figure 22 - C38 Plots



C40 East



C40 East



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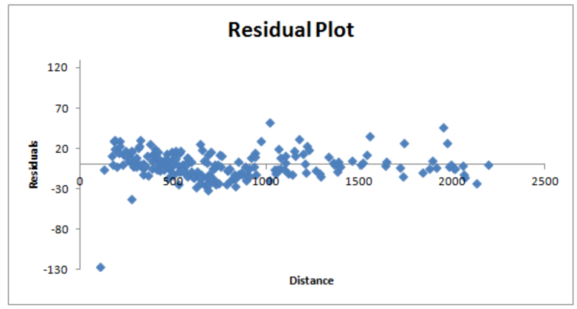

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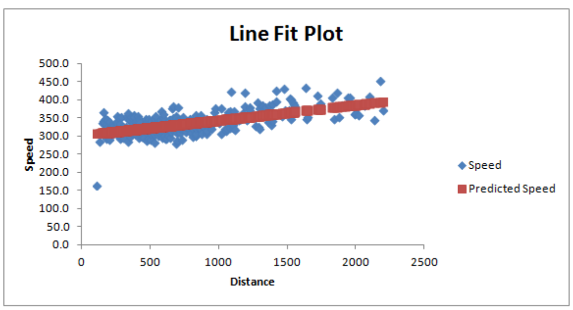
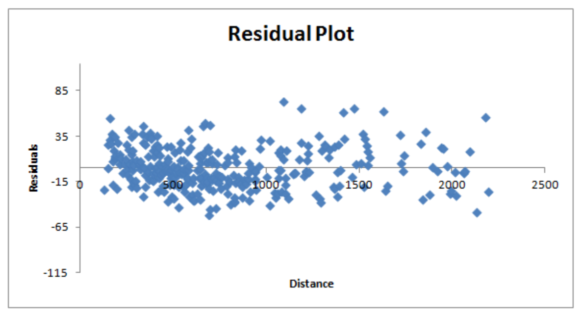
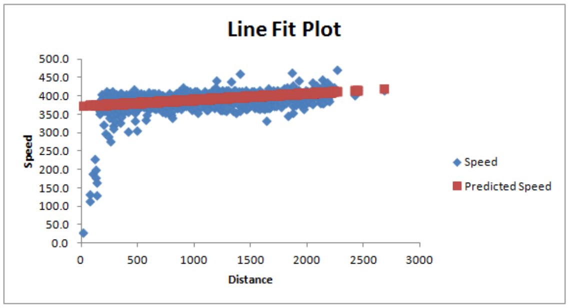


C40 All

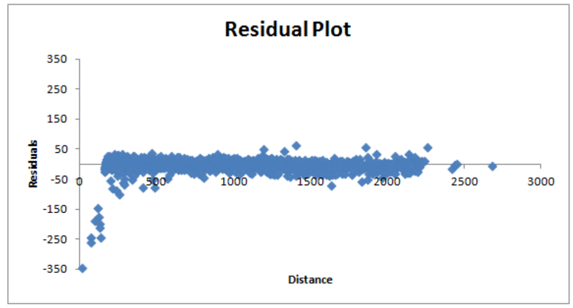


C40 All

Figure 23 - C40 Plots



C9B/DC9 East



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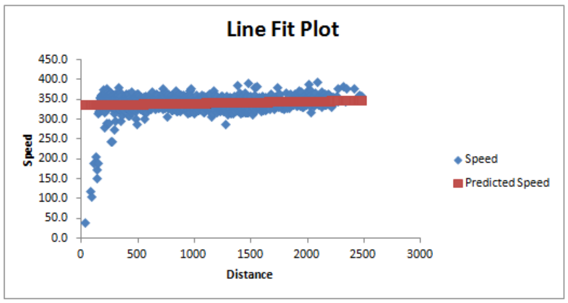
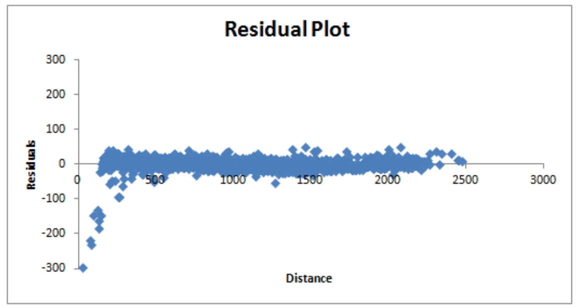
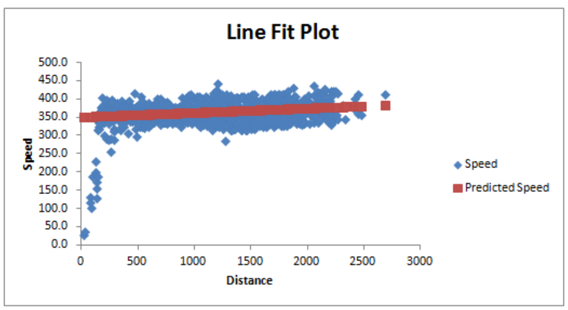


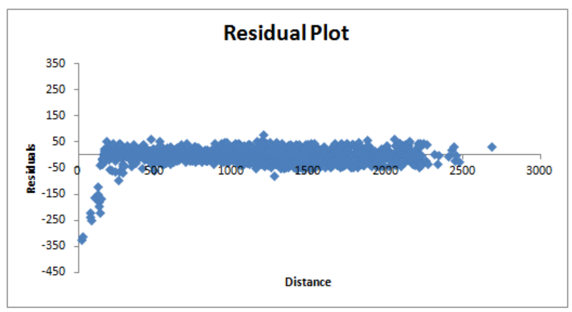
C9B/DC9 West



C9B/DC9 West

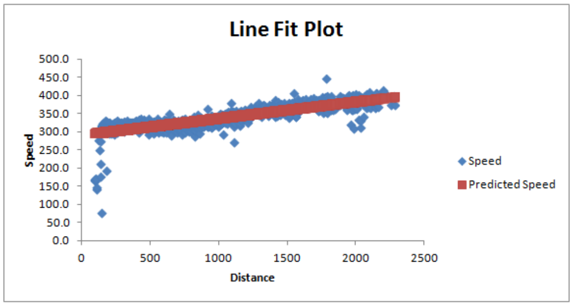


C9B/DC9 All

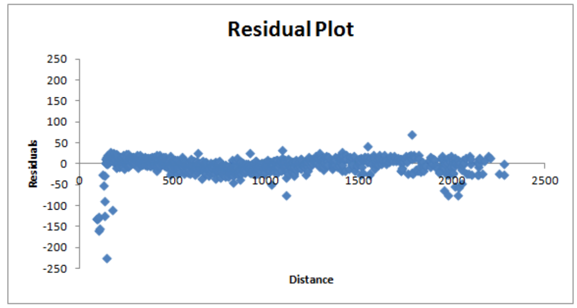


C9B/DC9 All

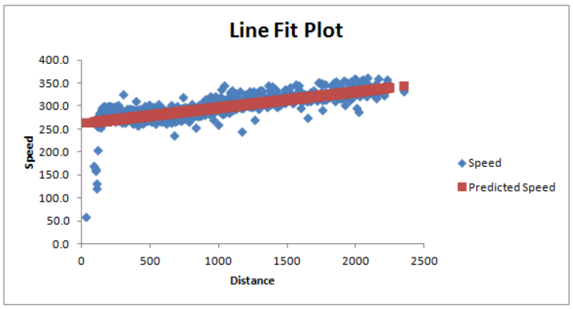
Figure 24 - C9B/DC9 Plots



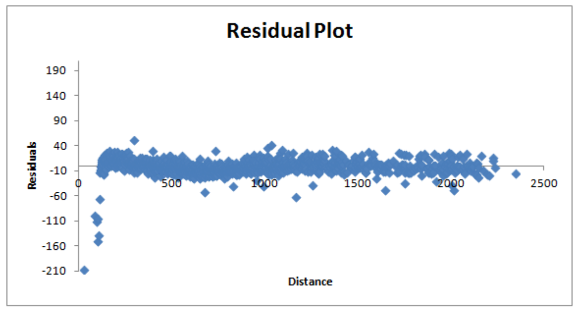
UC35A/B/C/D East



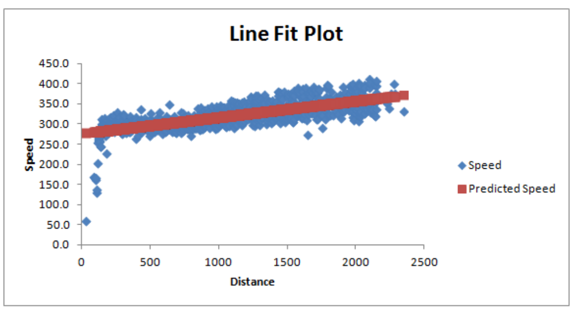
UC35A/B/C/D East



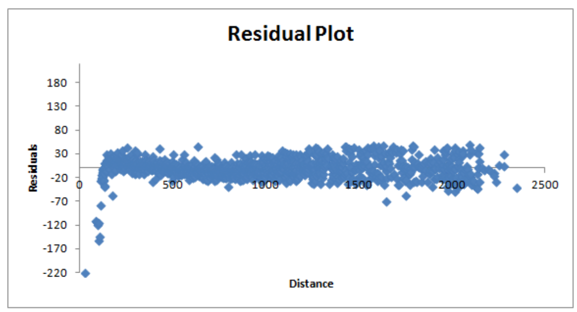
UC35A/B/C/D West



UC35A/B/C/D West

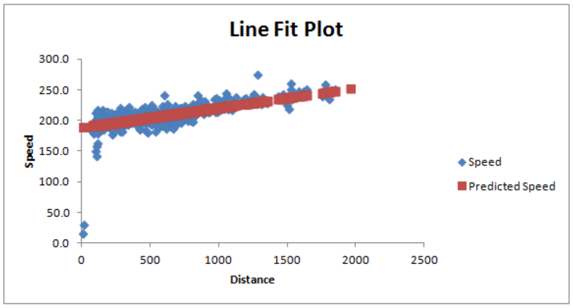


UC35A/B/C/D All

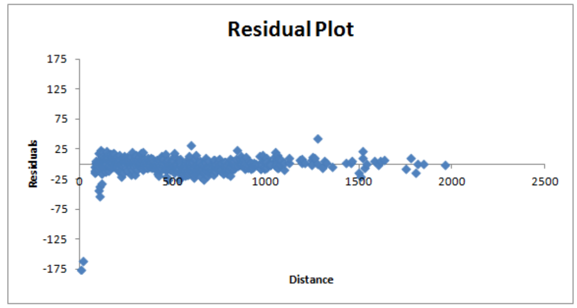


UC35A/B/C/D All

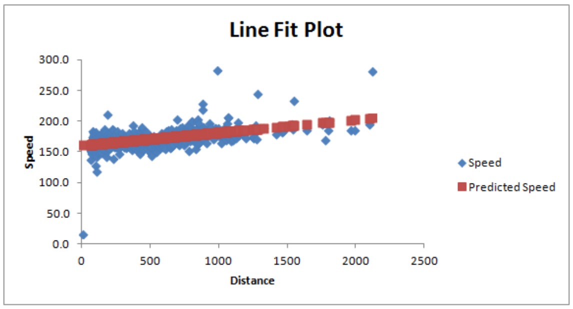
Figure 25 - UC35A/B/C/D Plots



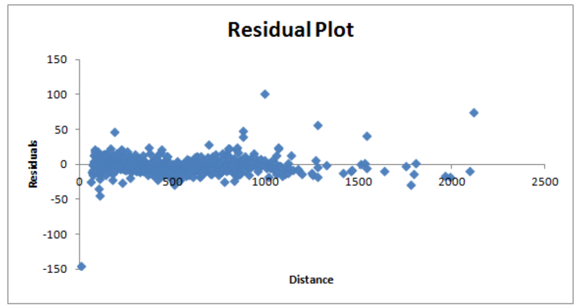
C12D/UC12M East



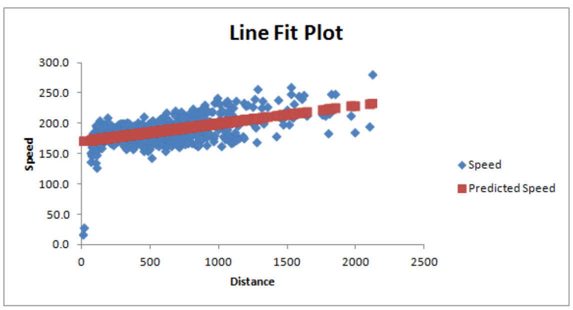
C12D/UC12M East



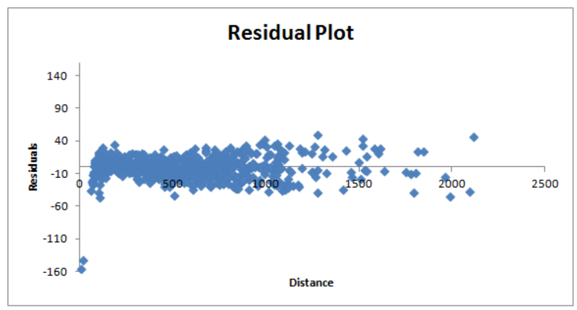
C12D/UC12M West



C12D/UC12M West

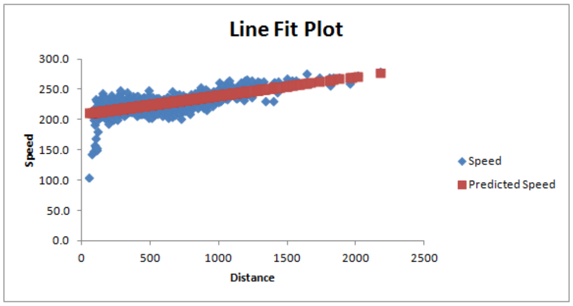


C12D/UC12M All

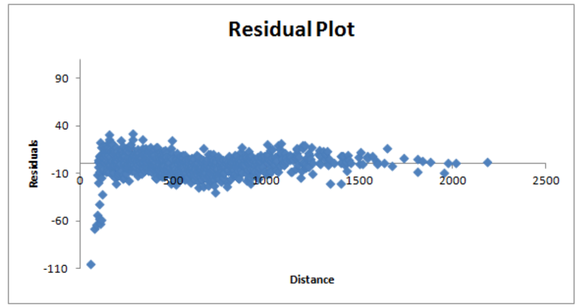


C12D/UC12M All

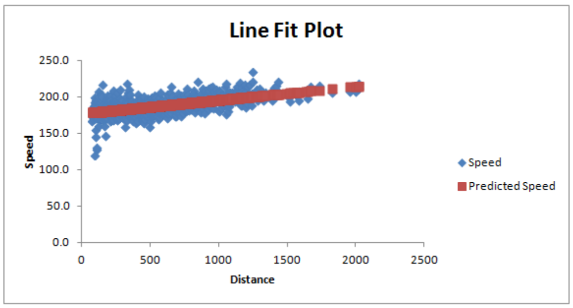
Figure 26 - C12D/UC12M Plots



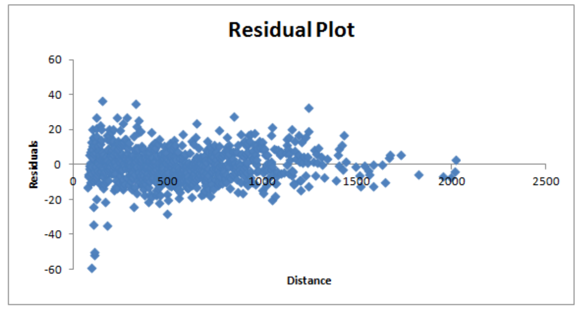
C12F East



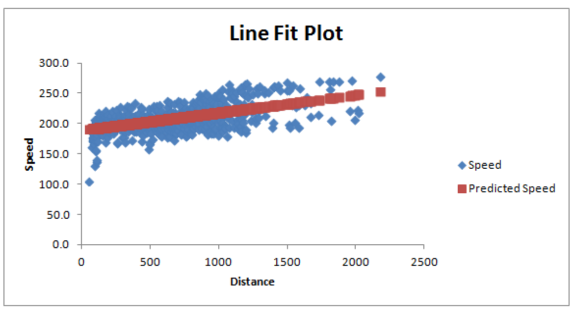
C12F East



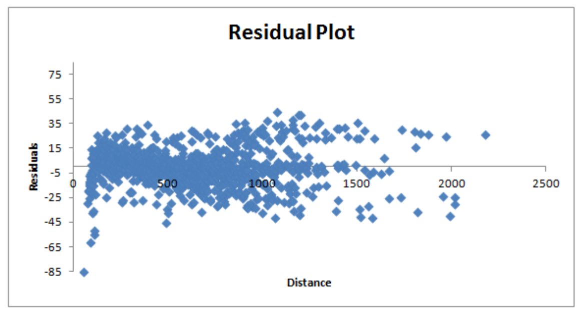
C12F West



C12F West

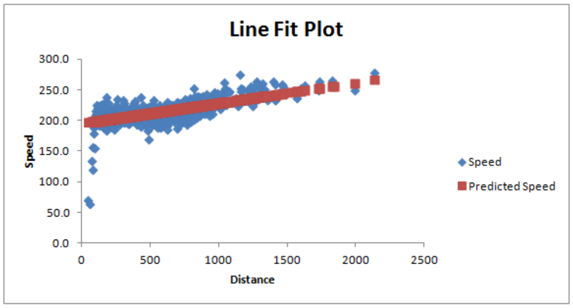


C12F All

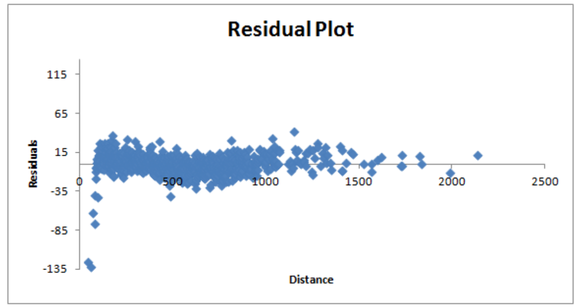


C12F All

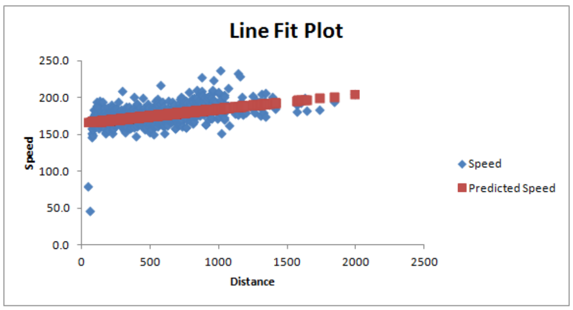
Figure 27 - C12F Plots



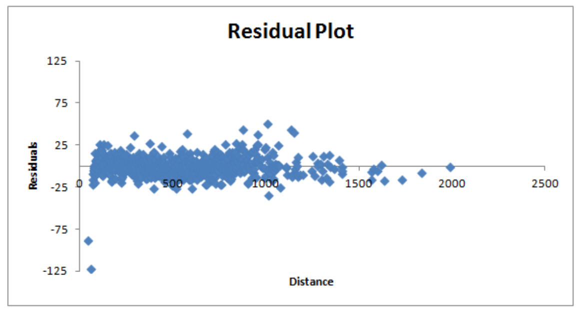
C12R/V East



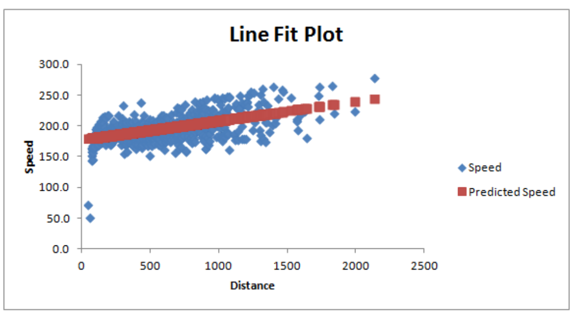
C12R/V East



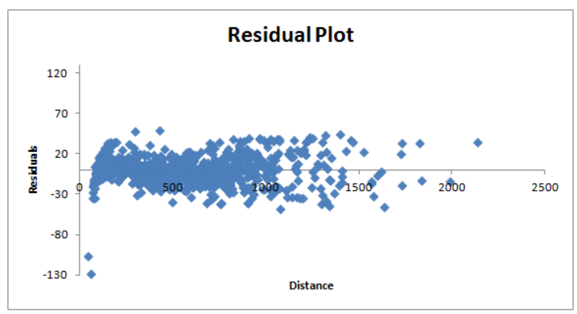
C12R/V West



C12R/V West

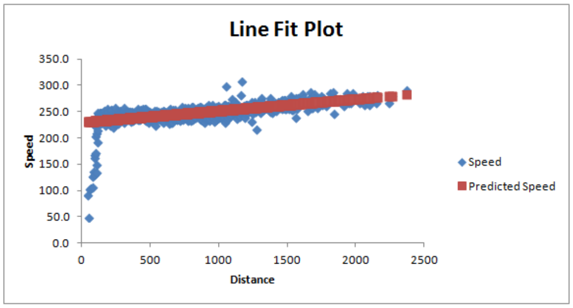


C12R/V All

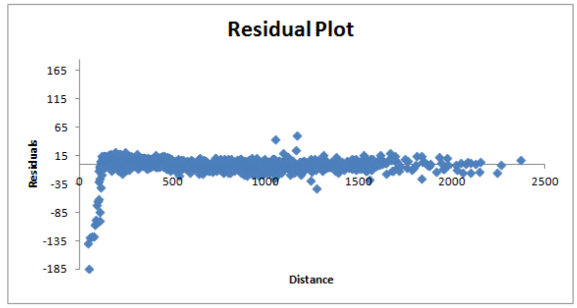


C12R/V All

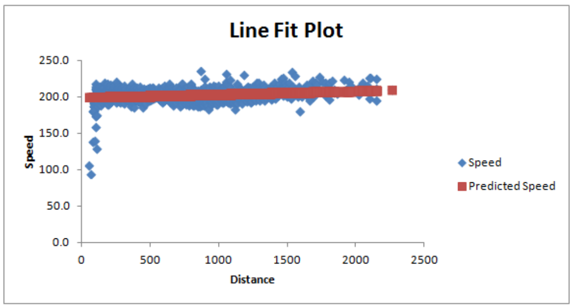
Figure 28 - C12R/V Plots



C12T/U East



C12T/U East



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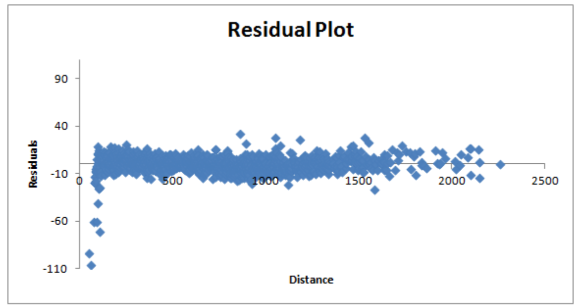
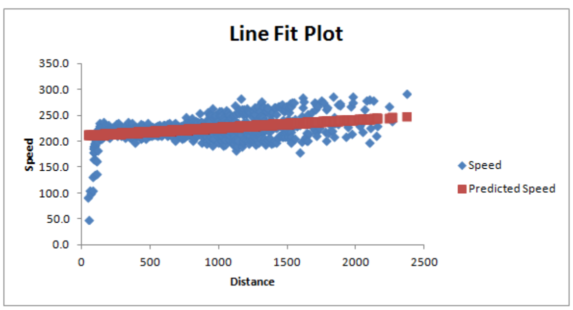
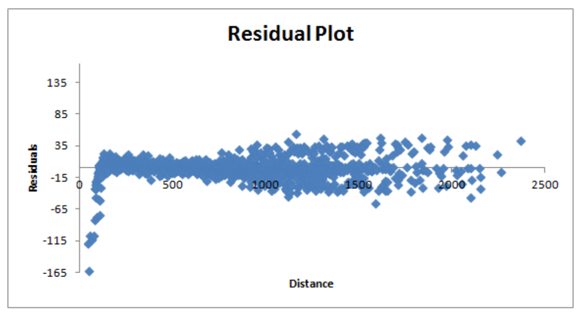


C12T/U West

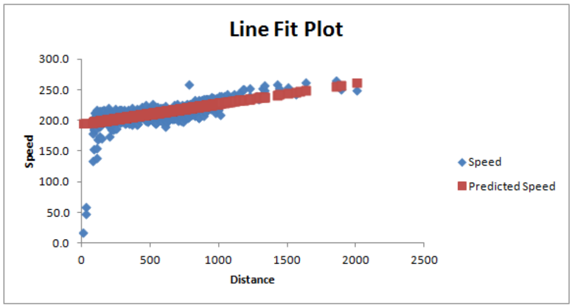


C12T/U All

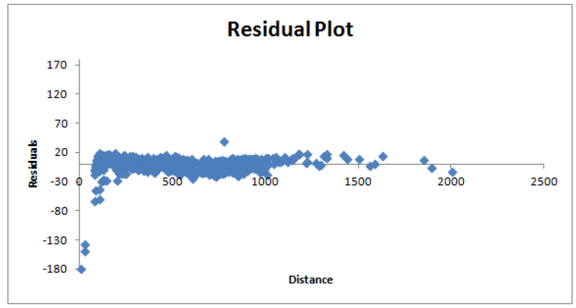


C12T/U All

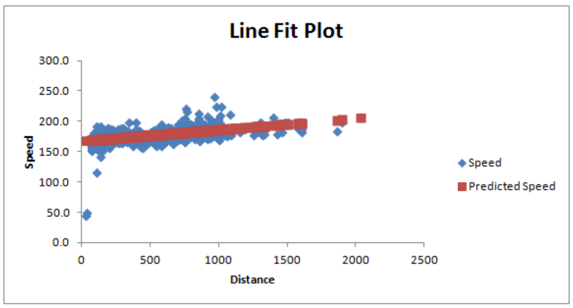
Figure 29 - C12T/U Plots



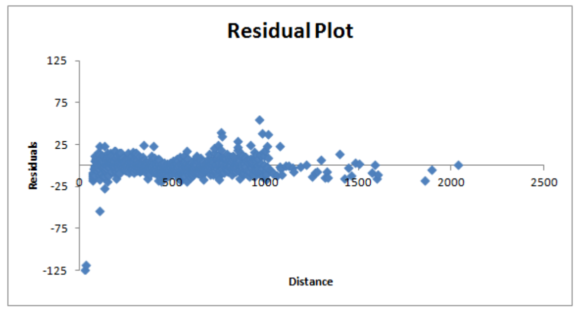
UC12B/F/W East



UC12B/F/W East



UC12B/F/W West



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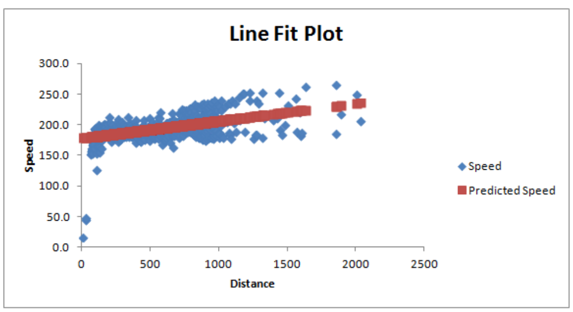

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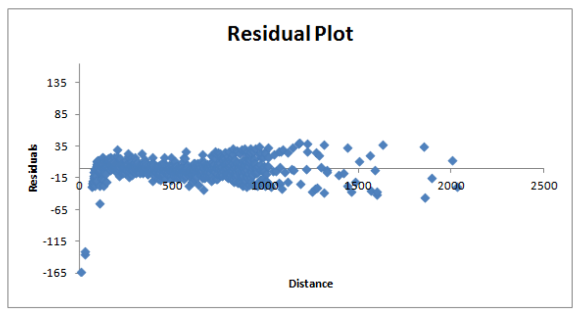

UC12B/F/W All

Figure 30 - UC12B/F/W Plots

Vita

Major Adam D. Simoncic graduated from Kadena High School, Okinawa, Japan, in 1994. He earned a Bachelor of Science degree in Mathematics from Creighton University in 1999. Major Simoncic earned a Master of Arts degree in Education from Touro University in 2005.

Major Simoncic attended Specialized Undergraduate Pilot Training at Vance AFB, Oklahoma. In 2001, Major Simoncic was assigned to the 457th Airlift Squadron, Andrews AFB, Maryland where he served as a C-21 Flight Examiner/Aircraft Commander. Major Simoncic was reassigned to the 2nd Air Refueling Squadron, McGuire AFB, New Jersey in January 2005 where he flew numerous KC-10 missions in support of Operations IRAQI FREEDOM and ENDURING FREEDOM. In September 2007, Major Simoncic separated from active duty and began work as a Production Flight Test Pilot at the Learjet factory in Wichita, KS. Major Simoncic was sworn into the Connecticut Air National Guard in 2010 and was assigned to the 103rd Air Mobility Operations Squadron as a Tanker Planner. In May 2012, Major Simoncic entered the Graduate School of Engineering and Management, Air Force Institute of Technology, Wright-Patterson AFB, Ohio. Upon graduation Major Simoncic will become a member of the Ohio Air National Guard and remain in the Dayton, Ohio local area.

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14. ABSTRACT
Joint Operational Support Airlift Center (JOSAC)/United States Transportation Command (USTRANSCOM) long range flight planners utilize a number of formulas and planning factors when planning missions. Currently, no aircraft block speeds table exists for Operational Support Airlift (OSA) aircraft. This research provides a method to calculate the aircraft block speeds table for JOSAC/USTRANSCOM aircraft. Evaluation of the model used in building the aircraft block speeds table requires examination of almost 200,000 flights over the course of almost five years. A linear regression model is incorporated resulting in unique equations that are used to create aircraft block speeds for specific flight distances.23 different United States Air Force (USAF) OSA aircraft models are examined. Statistics are analyzed and used to determine the significance and goodness-of-fit of the model to each aircraft. Results obtained from this research provide insights into the usefulness of a JOSAC/USTRANSCOM aircraft block speeds table. Overall, the models do a good job of predicting the speed of each aircraft per unit of distance. Based upon this research, it makes sense to create an OSA aircraft block speeds table to be used by JOSAC/USTRANCOM for long term mission planning.

15. SUBJECT TERMS
Block Speeds, Regression, JOSAC, USTRANSCOM

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